



WORLEYPARSONS FOR USAID

# ASSESSMENT OF LOCAL POWER GENERATION OPTIONS IN MOLDOVA,

## Progress Report, July 2019

REVISION 0.

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## INTRODUCTION

The objective of this progress report is to summarize current month's operations and performance, and present projections for major performance objectives for the next month.

## PROJECT PERFORMANCE

The following activities have been proceeding during the June of 2019.

Task	Start
Task 1: Assessment of existing CHPs and related DH facilities	May 31, 2019
Task 2: Heat and Electricity Demand and Supply	May 14, 2019
Task 3: Gas and Water Supply	May 1, 2019
Task 4: Land and Structural Issues	April 24, 2019
Task 5: Legal and Regulatory Consideration	May 16, 2019

Draft reports for the following tasks have been developed. Their in-house review and finalization are in progress:

Task 1 - Assessment of existing CHPs and related DH facilities.

Draft of Findings Summary is presented as Attachment A to this report

Task 2 – Heat and Electricity Demand and Supply.

Assumptions for Electric power demand are presented in Attachment B to this report

Assumptions for Heat demand are presented in Attachment C to this report

Task 5 - Legal and Regulatory Consideration.

Draft of Findings Summary is presented as Attachment D to this report

## PROJECT ISSUES

Data packages from the following stakeholders are still outstanding:

1. GN Fenosa
2. Vestmoldtransgaz

The following expediting efforts were undertaken to solicit the required data.

DATE	ACTIVITIES
July 5, 2019	Received Moldelectrica Development Plant for 2018-2027, and partial responses to the request for clarifications
July 9, 2019	Submitted an expediting request to Vestmoldtransgaz (T. Dutu) seeking information about the Ungheni-Chisinau gas pipeline project
July 12, 2019	Received a letter from Moldovagaz that further information could be obtained from the distribution system operators
July 15, 2019	Upon a preliminary discussion, submitted a letter to ANRE asking for information not provided by Moldovagaz.
July 19, 2019	ANRE forwarded Worley request for information to the respective natural gas distribution systems operators
July 23, 2019	Received from ANRE a map of Moldova gas transmission system with major infrastructure data. IPE conducted expediting telephone conference with Moldelectrica
July 24, 2019	Submitted a request for cooperation and information to WB (S. Ghidirim)
July 25, 2019	Received additional data from Moldelectrica
July 26, 2019	Received an input file for the PSS model for the Moldelectrica Power network
July 31, 2019	Received data from Cahul-Gaz SRL, an operator of the gas distribution pipelines in Burlaceni

## PERFORMANCE PROJECTIONS FOR THE NEXT MONTH

The following activities are projected to proceed during the July of 2019.

Task	Projected Finish
Task 1: Assessment of existing CHPs and related DH facilities	August 5, 2019
Task 2: Heat and Electricity Demand and Supply	August 16, 2019
Task 3: Gas and Water Supply	August 16, 2019
Task 4: Land and Structural Issues	August 16, 2019
Task 5: Legal and Regulatory Consideration	July 31, 2019



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# ASSESSMENT OF LOCAL POWER GENERATION OPTIONS IN MOLDOVA,

CLIN01 - Progress Report, July 2019

## Attachment A— Assessment of Existing CHP. Findings Summary

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## ACRONYM LIST

B2B	BACK-TO-BACK
CET	CENTRALA ELECTRICĂ CU TERMOFICARE
CHP	COMBINED HEAT & POWER GENERATION
CT	COMBUSTION TURBINE
CTP	CENTRALIZED THERMAL CONTROL POINT
DC	DIRECT CURRENT
DH	DISTRICT HEATING
DH NETWORK	DISTRICT HEATING TRANSMISSION SYSTEM
DHW	DISTRICT HOT WATER SUPPLY / SERVICE
DSM	DEMAND SIDE MANAGEMENT
ENTSO-E	EUROPEAN NETWORK OF TRANSMISSION SYSTEM OPERATORS FOR ELECTRICITY (EU)
HFO	HEAVY FUEL OIL
HOB	HEAT ONLY BOILER
HP	HIGH PRESSURE
HT	HIGH TEMPERATURE
IP	INTERMEDIATE PRESSURE
ITP	INDIVIDUAL THERMAL CONTROL POINT
LHV	LOWER HEATING VALUE
LPP	LOW PRESSURE PART
O&M	OPERATION & MAINTENANCE
OEM	ORIGINAL EQUIPMENT MANUFACTURER
SPH	SPACE HEATING

## CONDITION ASSESSMENT

CET-1 and CET-2 were designed, constructed, and commissioned during the Soviet time. Just like most power plants of this vintage CET-1 and CET-2 utilize standardized models of major equipment (such as boilers, steam turbines, generators, transformers, etc.), and their overall plant design and configuration is based on a centrally developed reference plant design. Over the years such power plants accumulated significant experience of long-term operation and maintenance of their equipment. This experience has been summarized and normalized in the Russian Federation standard RD-10-577-03

“Standard Regulatory Guidelines for Metallurgy Control and Service Life Extension of Major Components of Boilers, Steam Turbines and High-Pressure Pipelines of Thermal Power Plants”<sup>1</sup>. This document is mandatory for the Russian thermal power plants. However, it is applicable and is being widely utilized by the power plants located in the former Soviet republics that operate equipment of the same models and vintage as the Russian power plants.

The RD-10-577-03 methodology is based on a good engineering practice approach of establishing remaining service life of high pressure / temperature components of the power plant equipment. The standard defines in general three stages of the power equipment life extension:

- Operation within the Fleet Service Life limits
- Operation within the Specific Service Life limits when the Fleet Service Life limit is exceeded
- Operation beyond Specific Service Life limits.

The Fleet Service Life is expected reliable service life demonstrated by equipment of similar design and materials of construction, which was subjected to similar operating conditions, metallurgy control and maintenance.

The Specific Service Life is service life determined for a particular unit with its unique metal properties, geometric dimensions and conditions of its actual operation.

The Fleet and Specific Service Life determinations are applicable to equipment components made of steel that operate under high temperatures and pressure conditions, and are subject to slow plastic deformation under stress, a process known as creep.

The remaining useful service life of equipment components that are subjected to deterioration due to corrosion, erosion and other forms of wear and tear is determined by the results of periodic examinations of their de facto condition. Typically, such periodic examinations are conducted during the routine maintenance activities.

A comprehensive condition assessment is performed to determine equipment suitability for extended service and establish duration of the Specific Service Life once the equipment Fleet Service Life limit is reached. The scope of the assessment typically includes review of historical conditions of equipment operation, non-destructive examinations (such as radiographic testing, magnetic particle inspection, and liquid penetrant inspection), dimensional examinations (such as piping and tubing wall thickness), and metallurgy assessment to establish a remaining useful service life of a part.

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<sup>1</sup> РД-10-577-03 “Типовая инструкция по контролю металла и продлению срока службы основных элементов котлов, турбин и трубопроводов тепловых электростанций”, Госгортехнадзор России, 2003.

Based on many years of comprehensive assessments of equipment accumulated 300,000 or more hours of operation, including analysis of equipment deterioration mechanisms, and metallurgy assessments, it has been predicted that the duration of the equipment Specific Service Life can be on average at least 1.35-1.5 times of its Fleet Service Life<sup>2</sup>.

Fleet Service life and Specific Service life of a power unit is typically governed by condition of the unit's steam turbine, as replacement or overhaul of the steam turbine major components typically represents the highest one-time lumpsum cost.

Fleet Service Life for steam turbines is determined by their nominal output and throttle steam pressure (See Table 1)<sup>2</sup>.

*Table 1 Fleet Service Life for Soviet-made turbines*

OEM	Throttle Steam Pressure, MPA	Name Plate Output, MW	Fleet Service Life, 1,000 h	Number of Start-ups
Group A: UTZ (TMZ) Ural	Up to 9	≤ 50	270	900
	13-24	50-250	220	600
Group B: LMZ St Petersburg	Up to 9	≤ 100	270	900
	13-24	50-300	220	600
Group C: Turboatom Kharkov	Up to 9	≤ 50	270	900
	13	160	200	600

Per the classification above, the CET-2 turbines with output of 80 MW and throttle steam conditions of 13MPa at 545°C belong to Group B-equipment, which have estimated Fleet Service Life of 220 thousand hours. The lifetime hours in operation for the CET-2 power units are presented Table 2.

*Table 2 GET -2 Lifetime Operating Hours*

CET-2	UNIT 1	UNIT 2	UNIT 3
COMMISSIONED	1976	1978	1980
Operating HOURS	221 035	208 253	201 280

<sup>2</sup> Ресурс работы основного теплосилового оборудования тэс и оценка возможности его дальнейшей эксплуатации, В.Ф. Резинских (ОАО «ВТИ»), <http://www.combienergy.ru/stat/692-Resurs-raboty-osnovnogo-teplosilovogo-oborudovaniya>

Technical Inspection (Технадзор) of Ministry of Economics of Moldova is controlling agency, which oversees licensing of high-pressure piping and high-pressure boiler components in Moldova. Per the Technical Inspection requirements, boiler drums must undergo life / license extension assessment after 300 000 hours of operation. For steam turbine OEM recommendations are utilized.

CET-2 Unit 1 that reached 220 thousand hours of operation is scheduled for major overhaul and modernization during the summer of 2019 in order to renew its operating license. Scope of modernization is to include:

1. Increase steam flow rate through LP section
2. Installation of Low NOx burners

CET-2 Unit-2 is scheduled for major overhaul in 2021, and CET-2 Unit-3 in 2024.

The CET-1 turbines belong to Group-C equipment (Table I) with their power output less than 50 MW and throttle steam pressure of 9 MPa or less, at throttle steam temperature of 510 °C or less.

While the current lifetime operating hours for the CET-1 boilers and turbines have not been reported, it is likely that all of them have reached or exceeded their Fleet Service life limit. The power equipment of this type has been mostly decommissioned, especially at bigger power plants. However, such equipment can continue operation, albeit not economically feasible, provided proper maintenance and repairs are performed to extend their service life. It is likely that this equipment will be decommissioned at approximately 400,000 work hours of operation.

Fleet Service life for the boilers high pressure and temperature parts is expected as follows:

- Boiler Headers
  - CET-1: 250,000 h
  - CET-2: 300,000 h
- Boilers' Drums constructed of metal grade 22K or 16 GNM both for CET-1 and CET-2 is 300,000 h
- Main steam pipelines
  - CET-1: 250,000 h
  - CET-2: 350,000 h

In summary, the following remaining useful service life can be conservatively assumed:

- CET-2 Units 2, and 3 turbines have not reached their Fleet Service life of 220,000 h. Unit 2 turbine has approximately 12 thousand hours left before it would reach its Fleet Service life, Unit 3 has approximately 19 thousand hours left before it would reach its Fleet Service life. Unit 1 has reached its Fleet Service life, but it is scheduled for a major overhaul and license extension in 2019.

- Specific Service life for CET-2 Units 1, 2, 3 turbines is expected to be extended to 300,000 h, or additional 80,000 h beyond Fleet Service life limit. However, additional maintenance costs related to metallurgy assessments, maintenance and repairs are expected during the Specific Service life period.
- CET-2 Units 1, 2, 3 boilers have approximately 80,000 h of operation left before reaching their Fleet Service life limit.
- CET-2 Units 1, 2, 3 high pressure and temperature steam pipelines have approximately 50,000 h of operation left before reaching their Fleet Service life limit
- CET-1 ~ 300,000 h Fleet Service Life

At the pace of recent years of operation, given their low capacity factor (CF), the CET-2 Units 2 and 3 can likely be in operation for approximately another 10 years before exceeding their Fleet Service life and start requiring additional maintenance costs related to metallurgy assessments, maintenance and repairs expected during the Specific Service life period. Unit 1 should also be able to continue operation for approximately 10 years once its overhaul is completed and it is successfully re-licensed.

Because of the lower life steam parameters, the same could be said for the CET-1 units, another 10 years up to the ends of the Park resources.

The above assumptions notwithstanding, any of the CET-1 and CET-2 units could be taken out of operation and be put in reserve, mothballed or decommissioned because of economic reasons.

## **MINIMUM INVESTMENT FOR CONTINUOUS OPERATION OF EXISTING PLANTS**

### **PROPOSED INVESTMENT MEASURES**

The proposed measures offered here are targeting efficiency improvements of DH services in Chisinau. In general, efforts could be summarized in the following groups:

- To increase the volume of the DH services provided through:
  - Connection of as much as possible newcomers to the DH services, and re-connection of former customers where possible and where the load intensity is more than 3-4 MWth/ km, and where investments in the network are considered feasible.
  - To increase the access to DHW for all customers now served with Space heating only (roughly ~40% of the customers)
- To increase the capacity and efficiency of the services through:
  - Further rehabilitation, extension and upgrade of the DH network. Decrease of the heat losses below 20% first and further down to 14-15% through steady year by year network

repair, obsolete tubes replacements with pre-insulated state-of-the-art ones (long-term program now under way)

- Enhancement of the DH network capacity through efficient I&C control of the return temperature, thus keeping dT optimal alongside CHS replace program now under way, for example, to control  $dT \geq 30-31$  °C for all legs of the DH network, operation at  $T1/T2 \sim 77/45$  °C
- To increase the supply temperature T1 from the present max 77 °C to at least 90 - 100°C, while not deteriorating the network reliability goals.
- Extra efforts are needed to reduce the break-downs to 0.5 – 0.7 per kilometer or less than 350-450 per year
- Special programs and financing are needed to remove the existing bottlenecks, thus to enable operation in winter time for all of customers in one loop centered to CET-1 with a capacity of 700-800 Gcal/h, by replacing part of the network piping (some studies said those are pipelines ~11 km long). In this way, the CHP generation of both heat and power will become ~ 100% (now ~ 60-70%) of the heat delivered. So far, we have 100% CHP in the summer time for DHW supply only.
- Rehabilitation and life extension of CET-2 Units 1, 2, 3 now under way. The envisioned scope of works shall include:
  - Rehabilitation of the CET-2 Steam turbines' type PT-80/130 Cold end to Low-vacuum (T condenser 60-70 °C) operation mode, thus fully utilizing the low ~45 °C DH network return water temperature. This will reduce the heat losses to the existing natural draft cooling tower. The reduction will bring down the fuel costs for the generated power, increasing the competitiveness of the power produced in CHP mode.
  - A cost-benefit study considering Chisinau CHP plant selling the following services to the Moldova National Grid System operator, alongside with operation in cogenerating power and heat mode:
    - To be capable to operate at 240 MW in condensing mode by enhancing the CET-2 steam turbine cooling capacity (currently the available output is up to 160 MW gross).
    - Grid balancing, including against volatile renewable wind energy, that might come from Romania in case Moldova joins ENTSO-e or when B2B AS connection is commissioned.
    - Islanding mode of operation
    - Black start Capability

## EXPECTED PERFORMANCE (OUTPUT, EMISSIONS)

Expected final heat peak load demand is at the level of 1,400,000 Gcal/h because of the balance between the city population growth, dwelling stock extension, on one side, and potentially improved buildings efficiency and the DSM on the other side.

Proposal No 1 above will expand the number of Customers served, increase the summer demand and Improve of the quality of the services implementing further replacement of old and inefficient central heat substations (CHS) with modern fully-automated individual (now under way) thus increasing Customers self-control of the heat demand.

Proposal No 2 is aimed to decrease the heat losses below 20% first and further down to 14-15% through steady year by year network repair, replacement of deteriorated piping with pre-insulated state of the art piping (long term program now under way). This process is under way now and is highly important for the costs of service offered.

Enhancing of the capacity of the existing DH network through efficient I&C control of the return temperature thus keeping  $dT$  optimal, for example to control  $dT \geq 30-31^{\circ}\text{C}$  for all legs of the DH network, operation at  $T1/T2 \sim 77/45^{\circ}\text{C}$ . This measure is important to attract of new customers.

Further in Proposal No 2 the increase of the supply water temperature  $T1$  from now max  $77^{\circ}\text{C}$  to at least  $90-100^{\circ}\text{C}$  will increase further the capacity of the existing DH system, while not affecting the network reliability.

The extra efforts needed to reduce the break-downs to 0.5 – 0.7 per kilometer or less than 350-450 per year will return in better quality of the services, less O&M, higher confidence among the customers.

Proposal No 3 is aimed to further enhance the volume of power generated on CHP mode at least with 25-30% bringing all the customers of now HOB CT Vest and Sud to CET-2 in winter time. The Moldova self-generation will increase and the Termoelectrica SA revenues will improve.

Proposal No 4 will reduce the year by year O&M costs through better reliability, less forced outages, higher efficiency. Furthermore, Termoelectrica SA and its customers, will benefit from selling grid ancillary control services in addition to electric power to the Moldova Grid operator while taking an advantage of CHP's city of Chisinau location, which is the major demand center in Moldova.

All the proposals connected with efficiency enhancement of the DH services when implemented, will correspondingly reduce the  $\text{CO}_2$  emissions in the air.

Extension of the number of customers means less low altitude un-efficient heating devices thus significantly reducing the City ground level pollution.

The proposed measures will improve O&M of the Chisinau DH system through better reliability and higher efficiency of the services provided.

Estimated terms for proposed investments implementation would take at least 10 years.

## INVESTMENT TO EXPAND THE OPERATION OF THE CHP'S

The DH rehabilitation program currently underway is essential for the existing CHPs continuous operation. Inefficient and unreliable operation of DH system and potential reduction in DH customer base could make continuous operation of CHP economically unfeasible.

Our proposed approach for the CET-2 units' in operation is to proceed with gradual improvements/replacements of the outdated equipment. Based on Worley experience, relatively large capital-intensive projects typically need at least 5-6 years to achieve a financial investment decision and another 2-4 years till the commercial operation date. At this time the CET-2 units will be approaching the end of their useful life.

New capacity will improve Moldova power supply security due to the generation of more power with the same heat demand, will reduce O&M costs through better efficiency and reliability, will benefit DH customers, reduce the CO<sub>2</sub> emissions, and will subsequently reduce the city ground level air pollution.

*Table 3 Summary of investments for the next 10 years of existing CHP operation*

INVESTMENT NEEDED FOR EXISTING PLANTS	Scope	PERIOD, Years	INVESTMENT, 1000 USD
Based on the study and in- house experience for 10 years O&M as is		10	150,000
Fuel costs (natural gas) for 10 years		10	1,050,000
INVESTMENT NEEDED TO EXTEND THE OPERATIONS			
1. To increase the volume of the DH services provided, through:			
1.1. connection of new customers	O&M routine efforts		
1.2. To increase access to the DHW	The same as above		
2 Rehabilitation of the DH network as add up to what achieved			
Rehabilitation of ~ km total including insulation	332	10	68,877
Enhancing the carrying capacity of the existing DH network			
Trough IC control of the fluid temp. in the network		10	11,500
3. Winter operation in one loop and with CET-2 in CHP mode			
km total new pipes to resolve the existing bottlenecks	10	1	3,607
new pump station for the same purpose	1	2	
4. Rehabilitation of CET-2 Steam turbine Units 1,2,3			
including BoP and ST Cold end to decrease Cold end heat losses	3	6	44,800
<b>TOTAL INVESTMENTS TO EXTEND OPERATION EXISTING PLANTS</b>			<b>128,784</b>



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# ASSESSMENT OF LOCAL POWER GENERATION OPTIONS IN MOLDOVA,

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Attachment B- Power Demand Assumptions

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## ACRONYM LIST

CAGR	Compound Annual Growth Rate	IEA	International Energy Agency
CHP	Combined Heat and Power	MGRES	Moldavskaya TPP
HPP	Hydro Power Plant	OHL	Overhead Line
ENTSO	European Network of Transmission System Operators		

## INTRODUCTION/PROJECT OVERVIEW

This document presents major assumptions related to the electric power demand and electricity sector in Moldova, which will be used by Worley as a basis for the CLIN01 Task 2 Electricity Demand and Supply analysis.

## POWER ENERGY DEMAND

### BACKGROUND

According to the International Energy Agency (IEA)<sup>1</sup>, which presents jointly the consumption for Moldova for the left and right banks of the Dniester River, the electricity demand in Moldova dropped from about 9,000 GWh in 1990 to below 4,000 GWh in 2000. In 2007, a consumption of 4,155 GWh was reported by the IEA. This recent increase in demand is confirmed by input data in Moldova. Since 2001, the electricity demand increased by about 3 percent each year (3,195 GWh in 2001, 3,800 GWh in 2009, and 4,159 GWh in 2017). The power energy demand increase is mainly fueled by increasing household and commercial consumption (CAGR: +8% and +13% respectively), while industrial and agricultural consumption declined (-5% and -15%). There is an expectation that due to Moldova negative population growth rate (-1.06% in 2018<sup>2</sup>), as well as relatively slow economic growth, future demand for electric power may experience a sluggish development.

Exhibit I presents Moldova 1997-2017 annual electric power demand in GWh per year for the right bank of the Dniester river. As it can be seen, the annual power demand shows a slow recovery trend beginning 2000 that is preceded by a steep drop in demand during Moldova's transition to a market

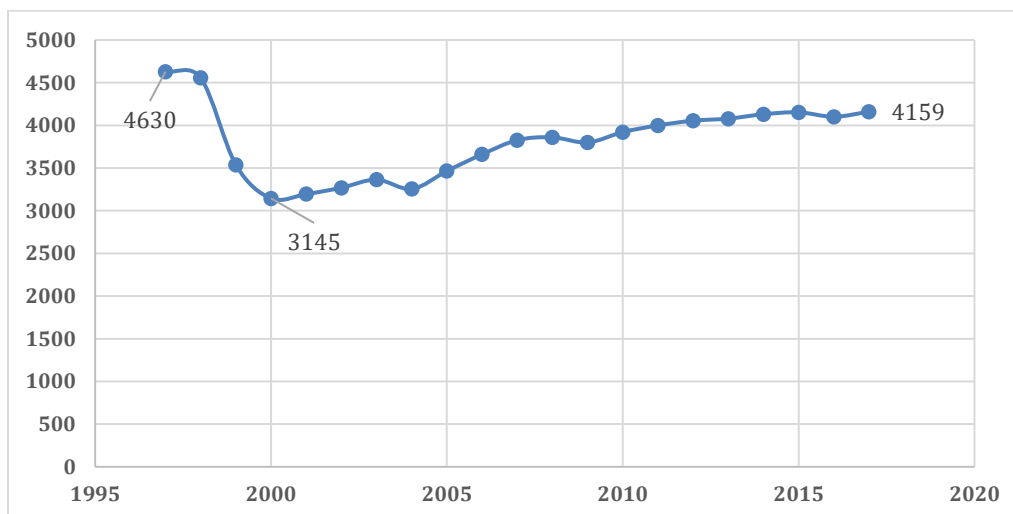
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<sup>1</sup> Policy Paper Series [PP/01/2010] Electricity Sector in Moldova: Evaluation of strategic options Georg Zachmann Alex Oprunenco Berlin/Chişinău, September 2010

<sup>2</sup> US CIA World Fact Book, (<https://www.cia.gov/library/publications/the-world-factbook/geos/md.html>)

economy. The annual power consumption by the Dniester right bank has increased by approximately 6.1% between 2010 and 2017, at an average annual growth rate of approximately 0.76%.

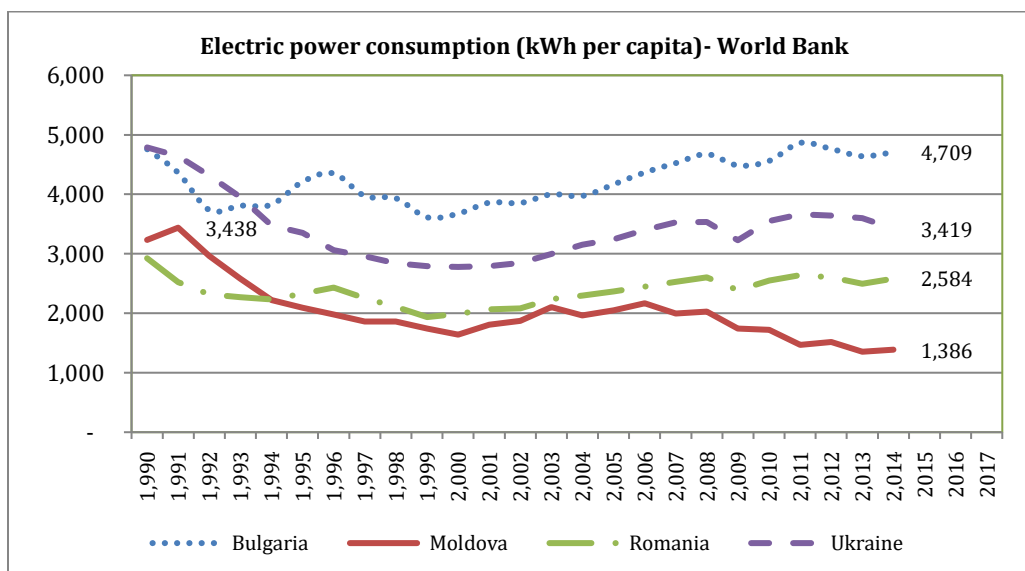
*Exhibit 1: Moldova Power Demand – right bank (1997 – 2017), GWh/a*



## POWER DEMAND PER CAPITA

Exhibit 2 presents 1990-2015 annual electric power consumption per capita in several neighboring Eastern European countries – Moldova, Bulgaria, Romania and Ukraine. Annual electric power consumption per capita for Moldova exhibits a negative trend for the recent years.

*Exhibit 2: Electric Power Consumption (kWh per capita)*



## POWER DEMAND PER SECTORS

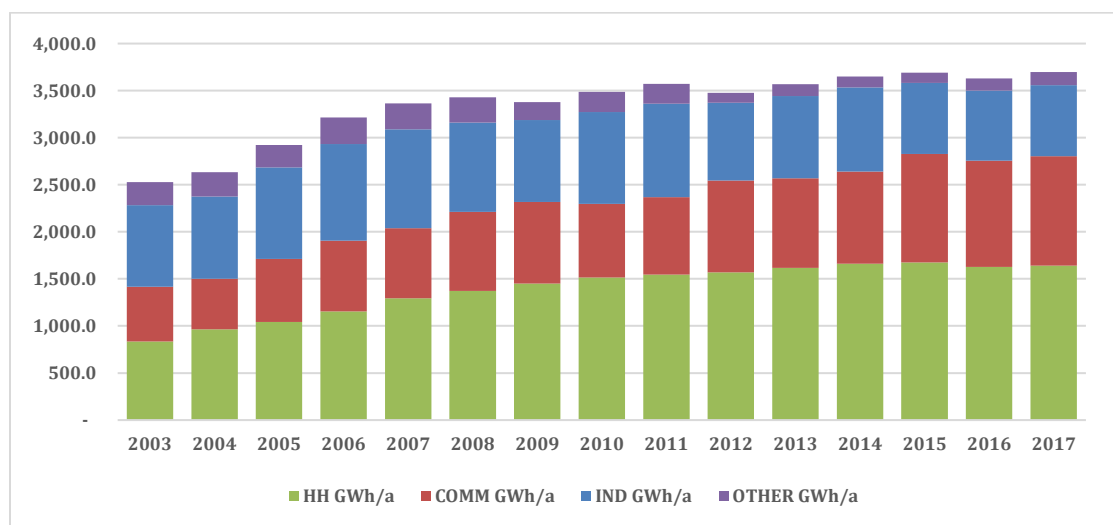
Exhibit 3 presents power demand distribution in Moldova (right bank only) by sectors of economy<sup>3</sup>. The distribution shows a steady decline of power demand by industry and growth of power demand for commercial and residential sectors.

*Exhibit 3: Moldova Power Demand Distribution by Sectors (Right bank)*

SECTOR	UNIT	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Industry	GWh/a	865	871	974	1,026	1,049	948	872	975	992	826	872	895	756	744	756
Commercial	GWh/a	581	539	671	753	745	841	866	783	821	977	953	977	1,151	1,128	1,163
Residential	GWh/a	836	964	1,041	1,154	1,295	1,371	1,450	1,514	1,547	1,570	1,616	1,663	1,674	1,628	1,640
Other	GWh/a	245	260	235	282	275	268	190	214	211	105	128	116	110	128	140
TOTAL	GWh/a	2,527	2,634	2,921	3,215	3,364	3,428	3,378	3,486	3,571	3,477	3,570	3,651	3,692	3,628	3,698

The recent trends of the Moldovan economy are reflected in the power demand structure as illustrated in Exhibit 4.

*Exhibit 4: Moldova Power Demand Structure (right bank) for 2003 – 2017 (GWh/a)*



<sup>3</sup> Country statistics, 2010 and 2017

## POWER DEMAND (RIGHT BANK VS LEFT BANK)

Exhibit 5 provides<sup>4</sup> a comparison in the power generation, import, demand and HV losses between the Moldova two energy regions: the right bank and the left bank of Dniester river for the period 2014 - 2017.

*Exhibit 5: Power Demand (Right bank vs Left bank)*

Parameter	Unit	2014	2015	2016	2017
<b>Generation</b>					
- Right Bank	GWh/a	776.7	781.1	750.2	735.2
- Left Bank	GWh/a	3,879.1	4,530.0	4,357.7	3,548.2
<b>Import</b>					
- Right Bank	GWh/a	730.7	17.6	3.7	1,133.9
- Left Bank		-	-	-	-
Total (Generation + Import)	GWh/a	5,386.5	5,328.7	5,111.6	5,417.3
<b>Power Demand</b>					
- Right Bank	GWh/a	-4,118.2	-4,141.2	-4,097.0	-4,147.7
	%	80%	81%	83%	80%
- Left Bank	GWh/a	-1,011.6	-973.1	-827.3	-1,036.7
	%	20%	19%	17%	20%
Total Demand	GWh/a	-5,129.8	-5,114.3	-4,924.3	-5,184.4
<b>HV Losses</b>					
- Total	GWh/a	256.7	214.4	187.3	232.9
- In %	%	-5.0%	-4.2%	-3.8%	-4.5%

The trends in power demand for Moldova's right and left banks are summarized for the period 2001-2017 and presented in Exhibit 6 and Exhibit 7 below<sup>5</sup>.

<sup>4</sup> Data provided to Worley by Moldelectrica

<sup>5</sup> Cod: 2017.12 revA Electricity transmission network development plan for 2018-2027 period S.E. "Moldelectrica"

Exhibit 6: Power Demand in Moldova for 2001 to 2017 (GWh/a)

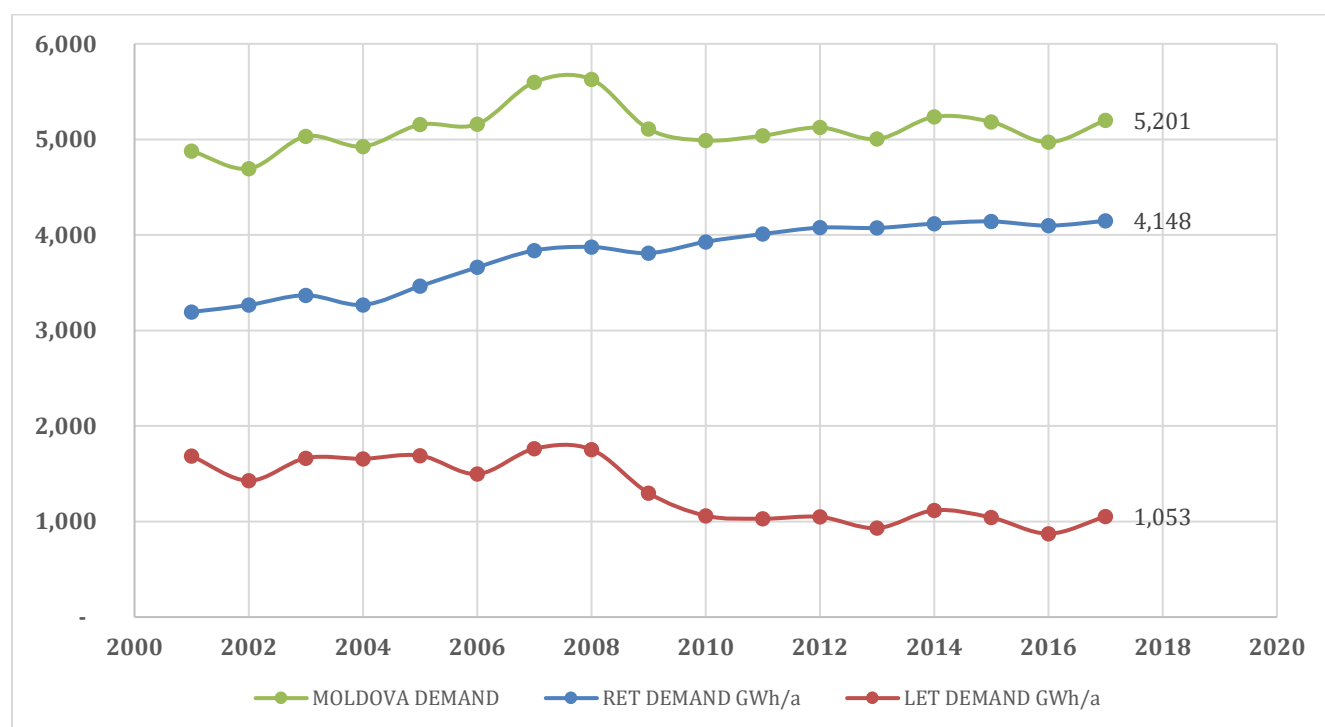


Exhibit 7: Power Demand in Moldova, right and left banks for 2001 to 2017 (GWh/a)

Year	Moldova	Right Bank	Left Bank
	GWh/a	GWh/a	GWh/a
2001	4,879	3,194	1,685
2002	4,694	3,266	1,428
2003	5,032	3,368	1,664
2004	4,925	3,268	1,657
2005	5,155	3,464	1,691
2006	5,159	3,661	1,498
2007	5,599	3,837	1,762
2008	5,628	3,874	1,754
2009	5,108	3,810	1,298
2010	4,989	3,928	1,061
2011	5,039	4,009	1,030
2012	5,124	4,076	1,048
2013	5,004	4,073	931
2014	5,236	4,118	1,117
2015	5,183	4,141	1,042
2016	4,971	4,097	874
2017	5,201	4,148	1,053

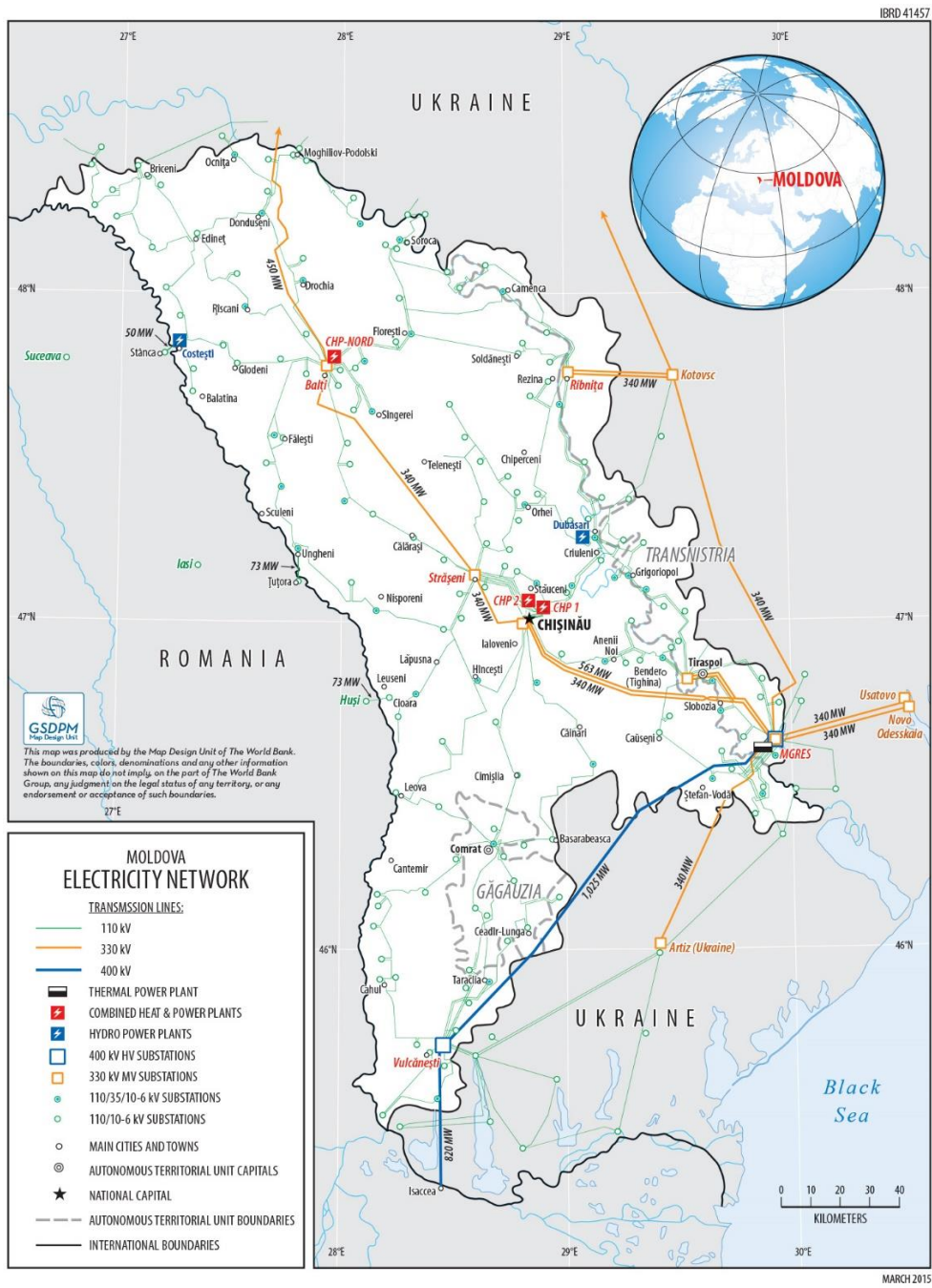
The presented data demonstrates a steady growth of the power demand for the right bank and notable decline of the power demand for the left bank of the Dniester river.

### **ELECTRIC POWER SYSTEM CAPACITY AND ADEQUACY**

Moldelectrica operating model assumes that the generating units of the system should be capable of generating electric power sufficient to balance the power demand and the power imported by the system. Thus, the installed/available generation capacities of the electric power system are considered adequate if they are capable to satisfy the power dispatch under any and all steady state normal operating conditions of the power system.

Exhibit 8 shows the power transmission map of Moldova including interconnections with neighboring countries.

Exhibit 8: Power Transmission Map of Moldova with main interconnectors



The electric power system capability to satisfy Moldova's 2016 typical winter day and typical summer day power load is calculated by Moldelectrica<sup>6</sup> and presented in Exhibit 9.

*Exhibit 9: Moldelectrica adequacy estimation*

Nr.	Parameter	Typical Winter Day	Typical Summer Day
1	Generated power, MW	751	514
2	Import, MW	37	23
3	Export, MW	0	0
4	Demand, MW	818	566
5	Available capacity [5=1+2-3-4]	-30	-29

In accordance with the most recent energy strategy for Moldova<sup>7</sup>, it requires to *ensure security of electricity supply by creating a transportation system strengthened and balanced development needed interconnection capacity with neighboring countries grids and linking to be prepared entering ENTSO-E diversification of sources and routes of supply of electricity from the outside*. Under this strong criterion, significant efforts shall be allocated to reach that goal.

## **ELECTRIC POWER SYSTEM CAPACITY AND RELIABILITY**

The Republic of Moldova shares borders with Romania to the West, and with Ukraine to the North and East. However, their electric power systems do not work in parallel till present.

The electrical energy exchange between Romania and the Republic of Moldova is limited by the island operating mode because their electric power systems currently cannot be operated synchronously. The decision on the access to the interstate OHLs between Romania and the Republic of Moldova is taken by CNTEE - Transelectrica S.A. The maximum of electricity export from the electric power system of Romania in the period 2001-2016 was up to 775 GWh/a in 2008.

The electrical energy exchange between Ukraine and the Republic of Moldova is determined by the “control section”, its maximal power being limited by the technical requirements of electric power system operational reliability. The control section includes: 4 x 330 kV OHLs, 3 x internal OHLs of Ukraine's national power system, 330 kV OHL Adjalik - Usatovo I, 330 kV OHL Adjalik - Usatovo 2

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<sup>6</sup> Cod: 2017.12.revA Electricity transmission network development plan for 2018-2027 period S.E. “Moldelectrica”

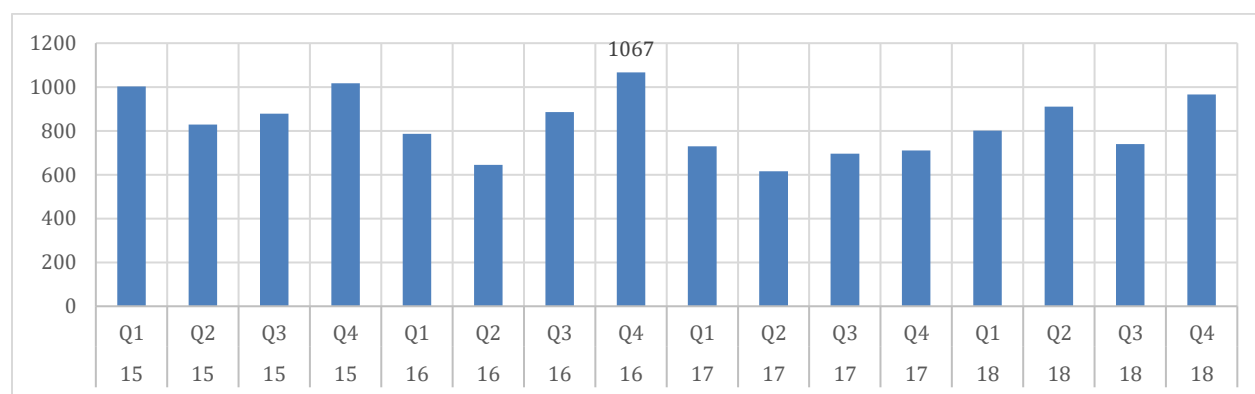
<sup>7</sup> Energy Strategy of the Republic of Moldova to the year 2030, Chisinau 2018

and the 330 kV OHL Ladijenskaia CHP - Kotovsk; and a tie between Ukraine - Moldova, 330 kV OHL Hydroelectric power plant Dnestrovsk – Bălți.

The bulk power transmission could be ensured by the mentioned above OHLs to the Republic of Moldova, Ukraine and the region of Odessa or the import/export at the same time. Maximum power transmission values for the control section are determined by its carrying capacity, which depends significantly on the topology of 330 kV OHLs and the compenence of those four electric power lines. Additional limiting factors include power generation by the Moldavskaya GRES (MGRES) and by the hydroelectric power plant Dnestrovsk. Therefore, due to the separation of the import/export areas on the OHL at the interstate boundaries, the allowable carrying capacity of the electrical energy imports from Ukraine to the electric power system of Republic of Moldova is the remnant value of the control section's transmission capacity, except for the region of Odessa. The maximum of electrical energy imports from the electric power system of Ukraine during the period 2001-2016 was 2,960 GWh/a in 2008.

Exhibit 10 presents the system maximum power load<sup>8</sup>, which was 1,067 MW in 2016Q4 as reported by the Operator for the period of 2015 to 2018. The system maximum power energy<sup>9</sup> for the same period is presented in Exhibit 11 and was 1,173 GWh in 2018Q4.

*Exhibit 10: System Maximum Power Load, MW (2015 – 2018)*



<sup>8</sup> Data provided by Moldelectrica

<sup>9</sup> Data provided by Moldelectrica

Exhibit 11: System Maximum Power Energy, GWh per quarter (2015 – 2018)

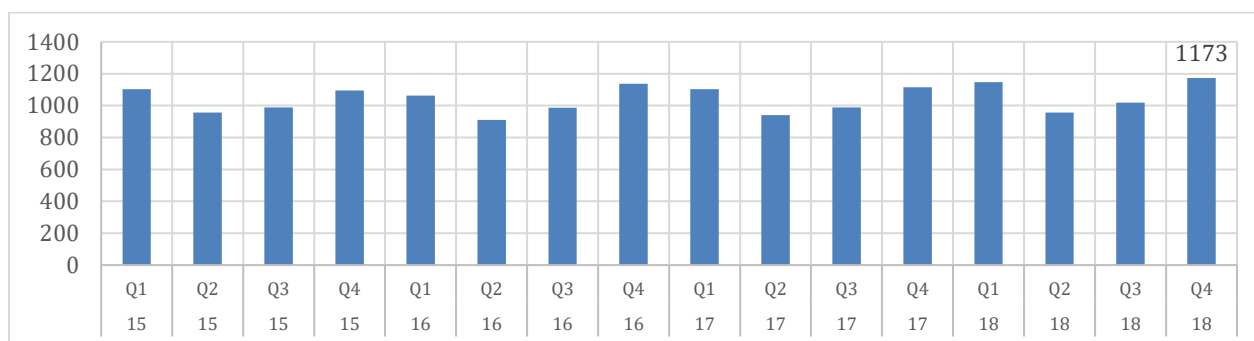


Exhibit 12 shows quarterly import of power per for the period 2017 to 2019 for the right bank of the Dniester river.

Exhibit 12: Import of Power per Quarter (right bank only)

Quarter	Unit	2017				2018				2019
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
Ukraine	GWh/Q	0	695	275	164	146	258	281	271	225
	%	0%	74%	28%	15%	13%	27%	28%	23%	20%
Romania	GWh/Q	0	0	0	0	0	0	0	0	0
	%	0%	0%	0%	0%	0%	0%	0%	0%	0%
MGRES	GWh/Q	732	170	679	698	644	611	686	836	528
	%	66%	18%	69%	63%	56%	64%	67%	71%	47%
Total	GWh/Q	732	865	954	862	790	869	966	1,107	753
	%	66%	92%	96%	77%	69%	91%	95%	94%	67%

## SECURITY OF SUPPLY OF MOLDOVA DISTRIBUTION GRID

The reliability of the power supply to the distribution network customers is regulated by Decree (DECISION on approval of the regulations on the quality of services and transfer of electricity distribution № 406 25.02.2011) in terms of ininterutibility of supply SAIDI index being less than 400 min after 2014.

The figures reported by Moldelectrika in the recent years are presented in Exhibit 13.

Exhibit 13: Grid Distribution Reliability

Year	Power As Delivered	Power Not Delivered	Power Not Delivered as % of Contracted	Average Duration of Blackout
	MWh/year	MWh/year	%	min / year
2011				
2012	4,538,460	215	0.0047	26.70

Year	Power As Delivered	Power Not Delivered	Power Not Delivered as % of Contracted	Average Duration of Blackout
2013	3,952,280	220	0.0056	21.99
2014	4,005,600	261	0.0065	25.43
2015	4,031,100	78	0.0019	10.17
2016	3,986,900	256	0.0064	33.70
2017	4,035,600	298	0.0074	38.80
2018	4,183,500	216	0.0052	27.10

## INSTALLED CAPACITY

Moldova right bank installed capacity<sup>10</sup> is presented in Exhibit 14 and for the left bank in

Exhibit 15

Exhibit 14: Installed capacity in Moldova, right bank only

Power Plant	Type	Output [MW]	Notes
CET-1	CHP	66	
CET-2	CHP	240	
CET-NORD	CHP	24	
CET-NORD	CHP	15.5	2019
HPP Costecy		16	
Sugar Mills CHP	CHP	87	
Wind plants	4	2.34	2012-16
Biogas	3	2.80	2012-17
Photovoltaic	34	2.38	2012-18
<b>TOTAL</b>		<b>456.02</b>	

<sup>10</sup> Energy Strategy of the Republic of Moldova to the year 2030, Chisinau 2018

Exhibit 15: Installed capacity in Moldova, left bank

Power Plant	Type	Output [MW]	Notes
<b>MGRES</b>		2,520	
<b>HPP Dubasari</b>		48	
<b>CET Tirotex</b>		31	
<b>TOTAL</b>		<b>2,599</b>	

## MOLDELECTRICA GRID OWN ENHANCEMENT PROJECTS

The following considerations are included in the Moldelectrica Grid development plan to 2027.

As per Moldovan Energy Strategy document<sup>11</sup>, the target of diversification of electricity supply sources is envisaged to be achieved by accessing the EU electricity market, which could be accomplished is through the Back-to-Back (B2B) stations at Vulcănești, Bălți and Ungheni, capable of power flow and voltage control to minimize the power system losses.

At the same time, there is a need for extension of interconnections with Romania in order to increase the operational security and the interface transmission capacity.

In addition, interconnection with EU can potentially provide better wholesale power prices because of increased competition that could lead to a lower electricity price for the end consumers.

## INTERCHANGE CAPACITY ENHANCEMENT - BACK TO BACK CONVERSION STATIONS

According to the Energy Strategy of Republic of Moldova, the following Back-to-Back interconnection options have been analyzed:

- 400 kV OHL Isaccea – Vulcănești – Chișinău;
- 400 kV OHL Bălți – Suceava;
- 400 kV OHL Strășeni – Ungheni (an auxiliary line for increasing the transit flow through internal grid) and 400 kV OHL Ungheni – Iași.

Calculation of load flow regimes have been performed by considering interconnected synchronous operation with IPS/UPS powers system (interconnection with PS of Ukraine) and asynchronous operation, via Back-to-Back stations, with ENTSO-E continental power system (interconnection with PS of Romania).

<sup>11</sup> Energy Strategy of the Republic of Moldova to the year 2030, Chisinau 2018

The asynchronous interconnection of electric power systems of Romania and Republic of Moldova by back-to-back conversion stations is intended to increase the interchange capacity to the west of the Moldovan power grid.

### OVERALL INTERCHANGE CAPACITY ENHANCEMENT

The following steps are planned to increase the interchange capacity of the 400 kV OHL “Isaccea (RO) – Vulcănești (MD)” and four 110 kV OHLs:

- Construction of 400 kV OHL “Suceava (RO) – Bălți (MD)” that depends on the construction of the 400 kV OHL “Suceava – Gădălin”, being included by Transelectrica SA in the development plan of electric transmission network of Romania for 2018 [2, pag.16, page.156].
- Construction of the 400 kV OHL “Suceava - Bălți” is planned for the period 2017-2022, following construction of the 400 kV OHL “Gădălin-Suceava”.

### PROJECTS IN ROMANIA

Other projects intended for the interchange capacity enhancement with Republic of Moldova will be carried out as part of finalization of the electric transmission network development plan of Romania. These projects to include construction of a third 400 kV OHL in Iași – Ungheni area and additional interconnections of the existing electric transmission network to the local electric distribution systems.

### MOLDELECTRICA TRANSMISSION NETWORK REHABILITATION PROJECT

Another project that should be mentioned is implementation of the “SE Moldelectrica Transmission Network Rehabilitation Project” that is financed by European Bank for Reconstruction and Development (20 mln. USD), European Investment Bank (17 mln. USD) and Neighborhood Investment Facility (8 mln. EUR grant). The project has an estimated implementation timeframe of 4 years and is intended for replacement of old equipment and reconstruction/construction of the 110 kV OHL and 110kV substations.

### 2018 – 2027 MOLDELECTRICA GRID REHABILITATION PROGRAM (CONNECTION TO ENTSO-E)

The rehabilitation plan of Moldelectrica grid comprises the milestones to rehabilitate the Moldovan Power Grid in order to synchronously connect to ENTSO-E at the end of 2027.

- The following investments in new power generation capacities and new OHTL’s are envisioned:
  1. First and one of the most important steps is to construct a new 600 MW power plant in the suburbs of the town of Vulcanesti.
  2. Four new 400 kV Overhead Transmission Lines Vulcanesti - Chisinau to be installed in order to provide a secure transmission of the power generated by the new 600 MW Power Plant to the center of Moldova capital at power Substation Chisinau 400/330/110 kV.
  3. New 400 kV OHTL’s between Substation Balti and Substation Suceava must be erected to establish a reliable and secure 400 kV system in Moldova.
  4. New 110 kV OHTL’s to be installed to provide improved reliability of power supply of Moldova power consumers.

- Investments in Rehabilitation of the Existing Over Head Transmission Lines (OHTL's)
  1. Existing OHTL's 400 kV Vulcanesti - Isaccea have to be rehabilitated in order to provide improved reliability of power supply of Moldova power consumers.
  2. Existing OHTL's 330 kV have to be rehabilitated in order to provide improved reliability of power supply of Moldova power consumers.
  3. Existing OHTL's 110 kV have to be rehabilitated in order to provide improved reliability of power supply of Moldova power consumers.
  4. Rehabilitation of the existing and installation of new 35 kV OHTL's to provide improved reliability of power supply of Moldova power consumers.
  
- Investments in Erection of New Substations and in Rehabilitation of Existing Substations
  1. A new 400/110 kV substation needs to be added. The substation shall comprise three New 400/110 kV Power Transformers 3 x 350 MVA and applicable adjacent infrastructure. The new 400/110 kV substation shall have at least 3 new OHTL's directed to Substation Isaccea 750/400/110 kV in order to transmit the produced new power.
  2. The existing 330 kV substations shall be upgraded with new 400 kV switchgears and 400 kV OHTL's to support the connection to ENTSO-E System.
  3. Rehabilitation of the existing 330 kV switchgear of Substation Chisinau 330/110 kV shall be performed to provide a back-up power supply for the Moldovan Grid.
  4. Rehabilitation scope for all the main substations shall include replacement of the old panels, transformers, power and control equipment, as well as installation of new SCADA systems in all Priority Substations in order to achieve reliable communication with the Main Dispatch Center and with ENTSO-E System Substations.
  5. Rehabilitation scope of 330 kV and 400 kV substation shall include installation of 330 kV and 400 kV Power Transformers. The existing 200 MVA Power Transformers shall be replaced with new 350 MVA transformers of in order to achieve the expected increase of Moldovan Power Grid capacity to about 1800 MVA.
  6. The 110 kV Power Transformers that reached the end of their useful life at all of the 110 kV Substations shall be replaced with the new units. Priority will be given to the critical 110 kV Substations to address Reliable Distribution Power Supply issues.

Exhibit I6 shows initial data and expected commissioning dates for a few ongoing projects.

Exhibit 16: Projects under development

Project Name <sup>12</sup>	From	To	Length [km]	Voltage [KV]	Commissioning Date
B2B station at Vulcanesti	Vulcanesti				2023
Vulcanesti-Chisinau	Vulcanesti	Chisinau	159	400	2023
Balti-Suceava	Balti (MD)	Suceava (RO)	139	400	2027

## RECENT LOAD DURATION CURVES

Exhibit 17 shows the power demand load duration curves for 2018 and 2019 based on plans made by Moldelectrica.

Exhibit 17: Power Demand Load Duration Curves for 2018 and 2019

Load	Year 2018	Year 2019
MW	Duration [hours]	Duration [hours]
850	-	-
800	-	-
750	45	73
700	475	525
650	1,187	1,247
600	2,273	2,378
550	3,661	3,798
500	5,093	5,235
450	6,486	6,634
400	7,460	7,601
350	8,311	8,391
300	8,700	8,732
250	8,760	8,760
200	8,760	8,760
150	8,760	8,760

Exhibit 18 presents load profile for a representative day, third Wednesday of every month in 2019.

<sup>12</sup> Projects underway in development

Exhibit 18: 2019, third Wednesday, load profile, MW

hour	1/23/2019	2/20/2019	3/20/2019	4/17/2019	5/15/2019	6/19/2019	7/17/2019
23	786	691	664	730	561	748	701
22	860	763	730	822	675	847	811
21	932	812	792	901	724	801	717
20	891	834	845	874	677	817	765
19	958	817	858	806	671	782	785
18	973	752	790	847	663	836	788
17	909	758	764	856	674	862	738
16	857	768	801	872	687	864	750
15	872	772	795	922	692	840	825
14	898	778	800	873	688	885	794
13	898	783	799	894	692	901	836
12	897	828	811	928	699	844	838
11	853	840	817	913	723	874	765
10	908	838	819	940	728	891	806
9	832	488	819	891	716	795	732
8	593	491	760	888	657	726	715
7	421	478	710	730	567	600	542
6	494	481	645	606	449	500	473
5	501	476	585	556	400	445	448
4	503	474	557	562	399	450	502
3	505	480	570	546	393	456	434
2	528	498	571	558	411	469	532
1	664	536	565	556	434	497	489
0	658	615	619	620	477	561	630
max	973	840	858	940	728	901	838
avg	758	669	729	779	602	720	684
min	421	474	557	546	393	445	434



WORLEYPARSONS FOR USAID

# ASSESSMENT OF LOCAL POWER GENERATION OPTIONS IN MOLDOVA,

CLIN 01- Progress Report, July 2019

Attachment C - Heat Demand Assumptions

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## ACRONYM LIST

CHP	Combined Heat and Power	HDD	Heat Degree Days
DH	District Heating	ITP	Individual Thermal Point
DHW	Domestic Hot Water	O&M	Operation and Maintenance
DSM	Demand Side Management		

## INTRODUCTION/PROJECT OVERVIEW

This document presents major assumptions related to the heat demand by the Chisinau District Heating system, which will be used by Worley as a basis for the CLIN01 Task 2 Heat Demand and Supply analysis.

## CHISINAU HEAT ENERGY SUPPLY AND DEMAND

### CHISINAU HEAT GENERATION CAPACITIES

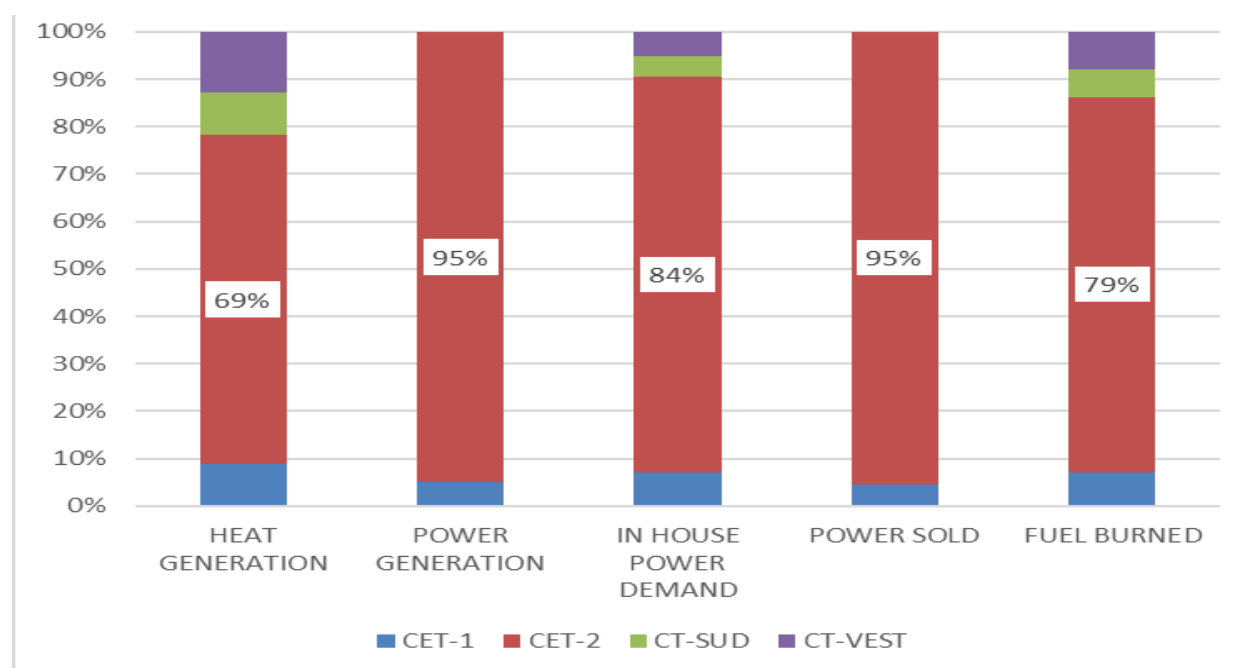
Exhibit I presents main technical data for the main heat generating capacities in Chisinau for the period of 2016 - 2018.

Exhibit 1: Chisinau Heat Generation Main Technical Data (2016 – 2018)

HEAT GENERATOR	HEAT GENERATION 2016-2018- MAIN TECHNICAL DATA					
	HEAT	POWER			FUEL	FUEL
	GROS	GENERATION	IN HOUSE	SOLD	NM3	
	GCAL	KWH	KWH	KWH		GCAL
CET-1	439,873	112,006,110	(25,248,250)	86,757,860	74,499,028	610,892
CET-2	3,400,992	2,126,251,260	(298,103,572)	1,828,147,688	822,293,560	6,742,807
CT-SUD	448,537		(14,793,300)		60,502,072	496,117
CT-VEST	624,239		(18,646,092)		82,389,207	675,591
<b>TOTAL</b>	<b>4,913,640</b>	<b>2,238,257,370</b>	<b>(356,791,213)</b>	<b>1,914,905,548</b>	<b>1,039,683,867</b>	<b>8,525,408</b>
	EFFICIENCY					
	THERMAL	POWER				
CET-1	89%	76%				
CET-2	82%	74%				
CT-SUD	90%					
CT-VEST	92%					
<b>AVERAGE</b>	<b>84%</b>	<b>72%</b>				
<b>REM.</b>	THERMAL	- heat gross +power generated/ fuel burned				
	POWER	- power generated/ (fuel burned - heat gross				
	SHARE OF THE HET GENERATORS IN:					
	HEAT GENERATION	POWER GENERATION	IN HOUSE POWER DEMAND	POWER SOLD	FUEL BURNED	
CET-1	9%	5%	7%	5%	7%	
CET-2	69%	95%	84%	95%	79%	
CT-SUD	9%	0%	4%	0%	6%	
CT-VEST	13%	0%	5%	0%	8%	

Exhibit 2 shows the respective share of CET-I, CET-2, CT-Sud and CT-West in heat and power generation in Chisinau.

Exhibit 2: Share of heat generation (2016 – 2018)



## CHISINAU HEAT GENERATION AND SUPPLY

The main technical data for years 2016, 2017 and 2018 characterizing the Chisinau district heating (DH) services are provided in Exhibit 3, Exhibit 4 and Exhibit 5.

Exhibit 3: Main Technical Data of Chisinau DH system for 2016

Month	Ambient Temperature [C]	DH Supply Temperature [C]	DH Return Temperature [C]	Gross Heat Energy [Gcal]	Heat Losses [Gcal]	Heat Losses [%]	Heat Energy Invoiced [Gcal]
January	-3.3	75.0	49.7	359,175	63,718	17.7%	294,865
February	4.7	67.5	45.1	245,457	29,913	12.2%	215,121
March	6.3	64.7	43.8	225,592	33,597	14.9%	191,611
April	13.1	63.4	43.1	44,180	17,754	40.2%	26,367
May	15.8	63.9	44.0	35,977	17,457	48.5%	18,484
June	21.3	63.8	45.1	30,403	15,352	50.5%	15,025
July	23.4	61.4	46.9	21,553	11,183	51.9%	10,349
August	23.1	60.4	46.5	22,445	11,393	50.8%	11,034
September	19.2	59.8	45.7	24,601	9,370	38.1%	15,207
October	7.9	62.20	44.90	119,998	41,136	34.3%	78,671
November	3.5	63.80	45.10	245,790	23,077	9.4%	222,381
December	-0.3	69.50	47.30	326,101	50,314	15.4%	275,324
<b>AVERAGE / TOTAL</b>	<b>11.2</b>	<b>64.6</b>	<b>45.6</b>	<b>1,701,271</b>	<b>324,265</b>	<b>19.1%</b>	<b>1,374,440</b>

Exhibit 4: Main Technical Data of Chisinau DH system for 2017

Month	Ambient Temperature [C]	DH Supply Temperature [C]	DH Return Temperature [C]	Gross Heat Energy [Gcal]	Heat Losses [Gcal]	Heat Losses [%]	Heat Energy Invoiced [Gcal]
January	-4.2	76.0	49.8	381,000	78,348	20.6%	302,113
February	-0.5	71.8	48.1	297,946	36,207	12.2%	261,274
March	7.8	63.0	44.0	199,883	34,665	17.3%	164,918
April	9.4	62.4	43.5	50,389	23,717	47.1%	26,579
May	16.4	60.4	44.9	37,657	22,607	60.0%	15,024
June	21.3	58.7	46.8	28,791	12,654	44.0%	16,112
July	22.4	58.7	47.5	25,117	12,935	51.5%	12,162
August	23.7	57.2	47.8	22,235	9,570	43.0%	12,648
September	18.6	58.9	46.6	25,230	12,027	47.7%	13,184
October	10.8	60.9	44.8	70,535	25,374	36.0%	45,031
November	5.5	62.3	45.0	231,354	47,013	20.3%	184,024
December	3.3	64.3	45.5	268,029	34,444	12.9%	233,207
<b>AVERAGE / TOTAL</b>	<b>11.2</b>	<b>62.9</b>	<b>46.2</b>	<b>1,638,166</b>	<b>349,562</b>	<b>21.3%</b>	<b>1,286,275</b>

Exhibit 5: Main Technical Data of Chisinau DH system for 2018

Month	Ambient Temperature [C]	DH Supply Temperature [C]	DH Return Temperature [C]	Gross Heat Energy [Gcal]	Heat Losses [Gcal]	Heat Losses [%]	Heat Energy Invoiced [Gcal]
January	-0.8	69.4	47.6	316,496	49,638	15.7%	266,346
February	-1.3	67.3	46.5	280,634	44,825	16.0%	235,385
March	0.8	68.3	47.2	303,522	41,825	13.8%	261,216
April	15.1	60.3	44.8	58,463	9,553	16.3%	48,811
May	19.4	60.4	46.1	32,434	15,830	48.8%	16,574
June	21.9	60.1	47.2	25,484	12,134	47.6%	13,335
July	22.2	60.3	47.5	25,722	13,074	50.8%	12,637
August	24.6	60.0	47.9	23,507	11,517	49.0%	11,979
September	17.9	59.3	47.0	26,164	13,423	51.3%	12,727
October	13.3	60.0	45.8	48,196	22,646	47.0%	25,471
November	2.1	65.4	46.4	245,251	45,189	18.4%	199,682
December	-0.8	70.0	48.6	326,730	56,175	17.2%	270,079
<b>AVERAGE / TOTAL</b>	<b>11.2</b>	<b>63.4</b>	<b>46.9</b>	<b>1,712,603</b>	<b>335,829</b>	<b>19.6%</b>	<b>1,374,243</b>

## CHISINAU DH SUPPLY – EXTREME DAYS

### MAXIMUM DH DEMAND – EXTREME COLD DAYS

Exhibit 6 shows average, maximum and average daily heat load for selected cold winter days during the 2016 – 2018 heating seasons.

*Exhibit 6: Maximum Gross Heat Demand (2016 – 2018)*

Date	Ambient Temperature [C]	CET-1 [Gcal/h]	CET-2 [Gcal/h]	CT-Sud [Gcal/h]	CT-Vest [Gcal/h]	Total [Gcal/h]
1/2/2016	-11.9	72	291	50	71	483
1/3/2016	-15.1	73	307	51	75	506
1/4/2016	-13.7	73	318	55	74	521
1/7/2017	-14.9	38	364	55	75	532
1/8/2017	-12.9	39	370	56	76	541
1/9/2017	-11.6	39	375	60	77	551
2/26/2018	-11.6	39	321	53	72	486
2/27/2018	-10.6	42	340	55	74	512
2/28/2018	-11.5	43	353	56	76	527
3/1/2018	-11.0	42	355	56	76	530
3/2/2018	-10.6	42	355	56	76	530
<b>Average</b>	<b>-12.3</b>	<b>49</b>	<b>341</b>	<b>55</b>	<b>75</b>	<b>520</b>
<b>Extreme</b>	<b>-15.1</b>	<b>73</b>	<b>375</b>	<b>60</b>	<b>77</b>	<b>551</b>

Exhibit 7 further details the system DH water flow rates and supply and return temperatures for selected cold winter days during the 2016 – 2018 heating season.

[illegible]

## MINIMUM DH DEMAND – CET-I DHW SUPPLY

Exhibit 8 presents maximum, average and minimum parameters for CET-I domestic hot water supply in Q3 of 2018. During the summer of 2018, CET-I provided DHW service for all the Termoelectrica SA DH customers in one loop.

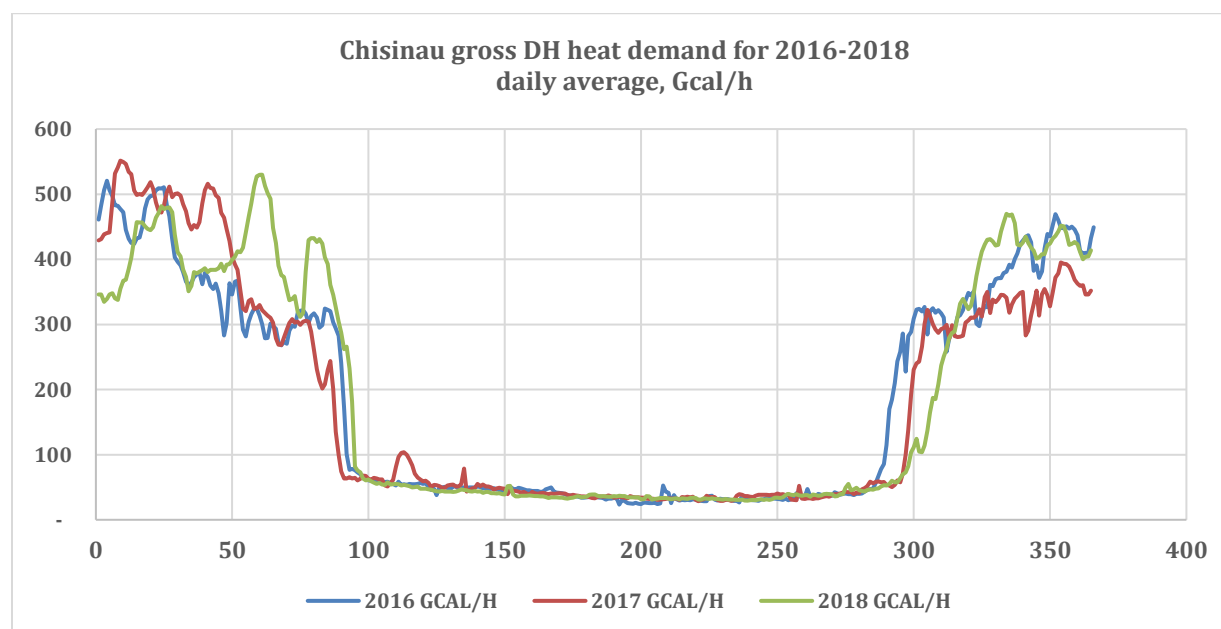
*Exhibit 8: CET-I DHW Supply (Q32018)*

	Gross Heat Demand [Gcal/h]	Water Flow Rate [m³/h]	DH Supply Temperature [C]	DH Return Temperature [C]	Delta T [C]
Maximum	40	3,136	64	49	16
Average	34	2,490	60	47	12
Minimum	28	1,857	57	46	11

## DISTRICT HEAT DEMAND CHARACTERIZATION

Daily average heat load profile presented in Exhibit 9 is provided by Termoelectrica SA and based on historical operating data in 2016, 2017 and 2018 for the all the heat sources CET-I, CET-2, CT-SUD and CT-VEST.

*Exhibit 9: Chisinau gross DH heat demand, daily average for 2016-2018*



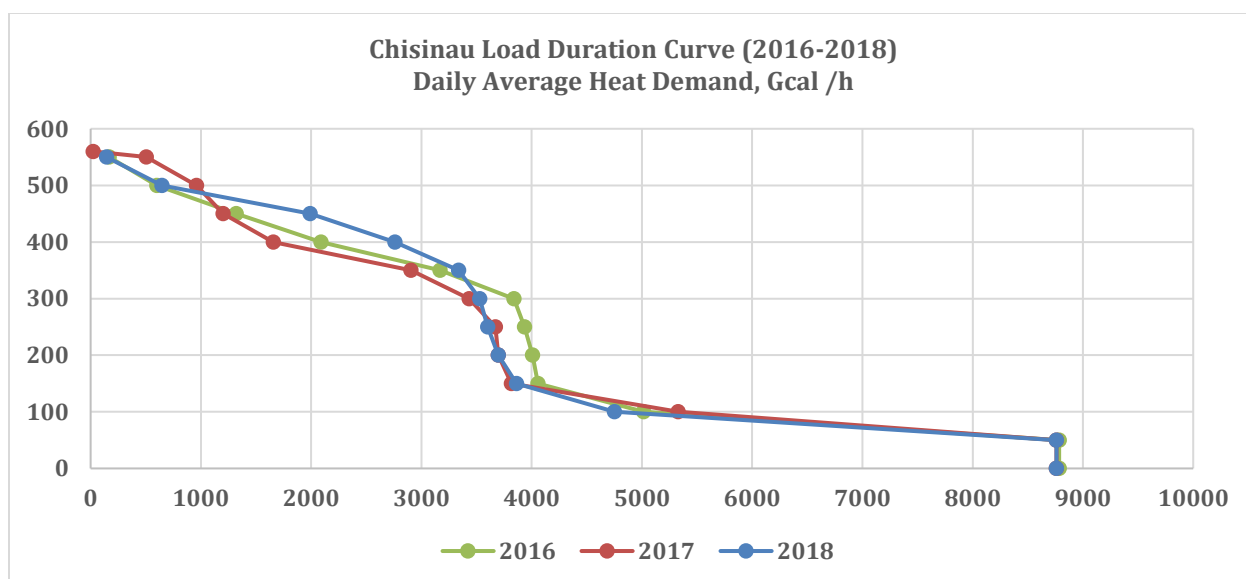
The heat demand can be characterized by the gross annual heat generation at the heat sources terminals, the recorded average peak daily load, the TLF (load factor – annual hours of operation at the peak load) and the actual annual heat degree days (HDDs). All these factors presented in Exhibit 10:

Exhibit 10: Main heat demand characteristics (2016 – 2018)

Parameter	Unit	2016	2017	2018
Heat Demand, Q	Gcal/a	1,659,474	1,601,101	1,667,906
Maximum Heat Load, Q <sub>max</sub>	Gcal/h	521	551	530
TLF	Hours	3,187	2,903	3,147
Heat Degree Days		3,351	3,345	3,460

The actual gross heat demand load duration curves for the selected three years are presented in Exhibit 11:

Exhibit 11: Actual Load Duration Curves (2016 – 2018)



## CHISINAU HEAT DEMAND PROFILE

Heat demand as a function of a cold weather is typically normalized by a cumulative frequency ambient temperature duration curve (Exhibit 12 and Exhibit 13). Standardized duration curves are based on the Soviet/Russian SNIIP standard (Construction Standards and Regulations) and have been developed for each city in Moldova. Exhibit 13 shows the data plotted for the city of Chisinau for the three recent consecutive years (2014 – 2017), and load duration curve developed based on ambient temperatures obtained from a public source<sup>1</sup>.

There are only few days with extremely cold ambient temperatures during a typical year in Moldova. Nevertheless, extremely cold conditions do occur, as it happened on February 2nd, 2012, when the

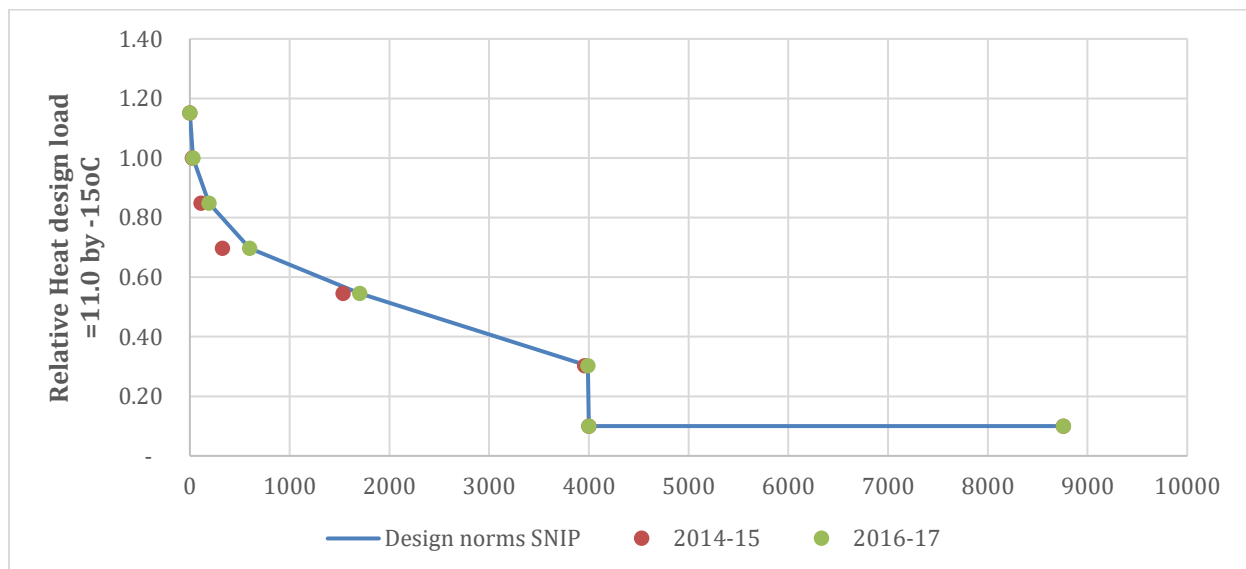
<sup>1</sup> <https://www.wunderground.com/history/wmo/33815/2015/10/1/DailyHistory.html>

average daily temperature was (-18.9°C), and the heat load demand for the Chisinau network reached approximately 650 Gcal/h.

Exhibit 12: Chisinau District Heating – Load Duration Curves

Design Load	Ambient Temperature [C]	Actual Data Recorded, [h]			Design Norms, [h]
		2014-2015	2015-2016	2016-2017	SNIP
1.15	-20.0	0	0	0	0
1.00	-15.0	24	24	32	46
0.85	-10.0	112	112	192	226
0.70	-5.0	328	384	600	615
0.55	0.0	1,536	992	1,704	2,140
0.30	8.0	3,960	3,320	3,992	3,980
0.10		4,000	3,360	4,000	4,000
0.10		8,760	8,760	8,760	8,760

Exhibit 13: Chisinau District Heating – Load Duration Curves



## HEAT DEMAND FORECAST (INPUT DATA)

### INPUT DATA

#### SPACE HEATING AND DOMESTIC HOT WATER DEMAND

The total residential area in the city of Chisinau throughout the years of 2005 to 2017 shown in Exhibit 14 is based Moldova State Statistics Bureau. Out of approximately of total 270 thousand apartments in

2017, space heating of 208 thousand apartments was provided by Termoelectrica SA. Termoelectrica SA provided domestic hot water (DHW) service to approximately 50% of the Chisinau apartments.

*Exhibit 14: Residential Apartments in Chisinau*

Year	Number of Apartments [000]	Total Area [000 m <sup>2</sup> ]	Average Area per apartment [m <sup>2</sup> ]
2005	250	8,643	35
2006	246	8,567	35
2007	249	8,732	35
2008	254	8,959	35
2009	258	9,111	35
2010	260	9,378	36
2011	264	9,601	36
2012	266	9,687	36
2013	271	9,867	36
2014	270	10,132	38
2015	274	10,306	38
2016	258	10,188	39
2017	267	10,370	39

Public sector annual heat demand was approximately 172,000 Gcal/a for space heating and 16,200 Gcal/a for DHW (including over 150 kindergartens and over 165 schools connected to the Chisinau DH network). For the year 2018 the total annual net heat demand reached approximately 1,375,000 Gcal/a.

### **SPECIFIC SPACE HEATING DEMAND**

According the ESCO Moldova Project<sup>2</sup> the current specific residential and public heat demand in Chisinau is well above the good engineering practices compared to EU countries (Exhibit 15).

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<sup>2</sup> ESCO Moldova Project – Moldova Green City/Promoting Low Carbon Growth in the City of Chisinau 2014

Exhibit 15: ESCO Project estimated efficiency benchmarks

Space Heating	EU typical kWh/m <sup>2</sup> /a	Chisinau estimated kWh/m <sup>2</sup> /a
Residential, min	60	110
Residential, max	75	140
Public, min	80	140
Public, max	100	180

According to the ESCO project, there is up to 40% potential for improvement in heat energy efficiency if various DSM measures are implemented in Chisinau.

#### DEMAND SIDE MANAGEMENT IMPACTS OUTSIDE DH SECTOR

The ongoing modernization of the DH substations that transfer heat to individual buildings helped with the heat demand control and facilitated savings in average heat consumption at the household level.

Significant reduction in heat consumption was overall a result of a combination of measures in the DH sector. These included prior measures to install individual thermal points (ITP) equipped with heat meters, and heat regulators (thermostatic valves) in radiators, and metering of heat consumption.

Upgrades of the existing building to improve their overall efficiency such as adding wall/roof insulation, replacing windows, etc. are expected to be implemented in Moldova at a relatively slow pace due to the high initial capital costs of such improvements. The list of recommended DSM measures to be goes beyond investments related to insulation of walls and roofs. The target is to reduce the energy consumption per sqm from 110-140 kWh/m<sup>2</sup>/a to 60-75 kWh/m<sup>2</sup>/a in multi-level residential buildings, for example, with the following package of DSM measures:

- Roof insulation
- Windows replacement
- Walls insulation
- Implementation of individual heating substation ITP

Balance of measures and their effect for the typical residential and public buildings is given in Exhibit 16 and Exhibit 17.

Exhibit 16: ESCO 2014 Chisinau Typical Residential Building - DSM

Building Element	Area [m2]	Initial Energy Losses [kWh/a]	DSM Efficiency	Energy Losses after DSM [kWh/a]
Floors	6			
Roof	372	8,958	4%	8,600
Windows	281	35,116	14%	30,200
Walls	1,239	216,298	50%	108,149
ITP	1	16,333	10%	14,700
Total		276,706		161,649
Living Area	2,254			
Sp. Energy Demand	kWh/m2/a	123		72
DSM Effect		100%	42%	58%

Exhibit 17: ESCO 2014 Chisinau Typical Public Building - DSM

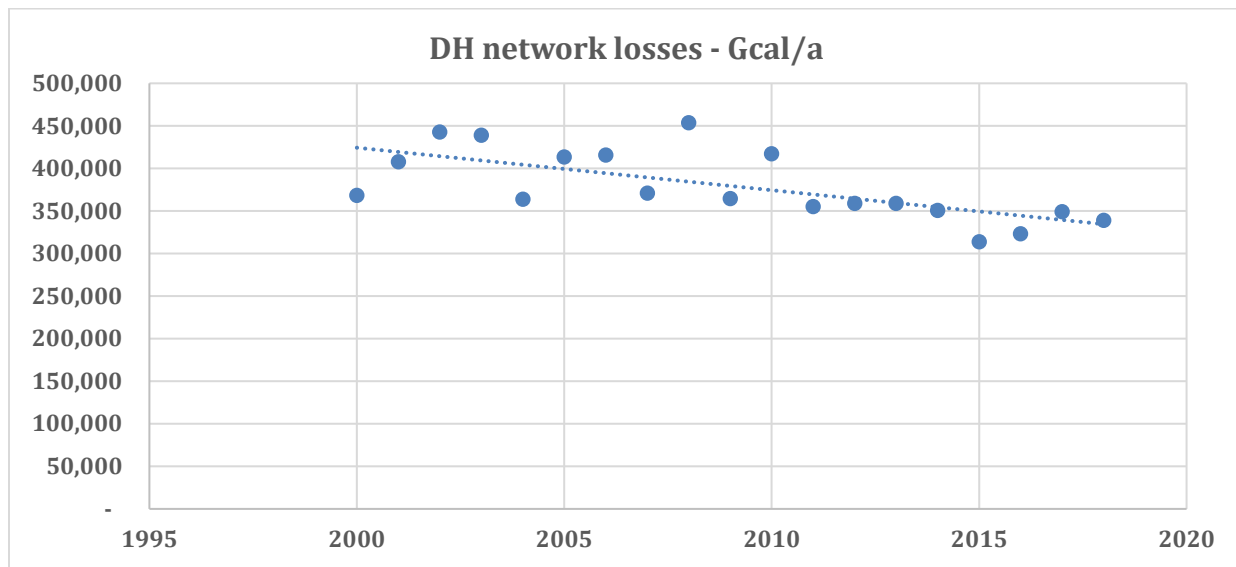
Building Element	Area [m2]	Initial Energy Losses [kWh/a]	DSM Efficiency	Energy Losses after DSM [kWh/a]
Floors	2			
Roof	1,789	82,652	11%	73,560
Windows	589	127,376	16%	106,996
Walls	2,633	376,158	36%	240,741
ITP	1	36,635	8%	33,704
Total		622,820		455,001
Living Area	3578			
Sp. Energy Demand	kWh/m2/a	174		127
DSM Effect		100%	27%	73%

It is assumed that the new buildings in Chisinau are initially designed and built to meet EU energy efficiency benchmarks.

## DH TRANSMISSION HEAT AND WATER LOSSES

Exhibit 18 shows the trend in DH network losses for the last 15 years. It should be considered that a comprehensive Chisinau DH rehabilitation program is under way since 2010.

Exhibit 18: District heating network losses



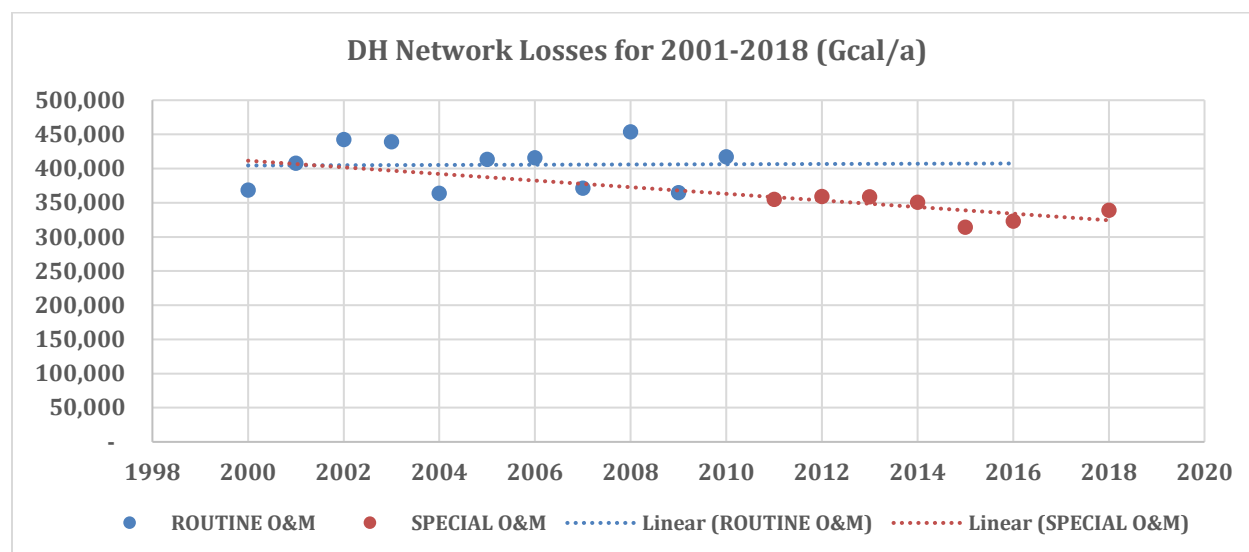
In the recent years the following dedicated O&M work had been completed as part of the DH rehabilitation program (Exhibit 19).

Exhibit 19: O&M measures from DH rehabilitation program

Year	DH Net Pipe Replaced [km]	O&M Expenditures [mln Lei]	DH Net Insulation [km]	O&M Expenditures [mln Lei]	Share from Total Length	Heat Losses Change [y/y%]
2010	11.20	12.40	42.00	8.90	0.046	
2011	10.60	11.50	34.50	3.90	0.038	-15%
2012	9.40	23.00	32.00	8.20	0.035	1%
2013	11.40	29.90	29.90	7.20	0.035	0%
2014	15.00	34.00	41.70	13.90	0.048	-2%
2015	2.90	12.30	17.00	7.60	0.017	-10%
2016	7.20	41.00	19.00	14.00	0.022	3%

The rehabilitation work is financed by Termoelectrica SA own funds and by the special World Bank project (SACET). Through the end of 2018, approximately 24% of the total DH network system had been rehabilitated, thus bringing down the overall heat losses to 339,000 Gcal/a in 2018, which is approximately 20% of the gross heat generation. The effect of the dedicated O&M measures on annual heat losses is presented in Exhibit 20.

Exhibit 20: Effect of O&M measures on DH network losses



In our understanding the DH network rehabilitation works will proceed further for the next 5-7 years. But we expect that the continuing improvement work will result in a somewhat diminishing effect on reducing the network losses, to the level of approximately 15% for the years of 2025-2032, or approximately 260,000 Gcal/a.

Throughout a year, the heat losses are distributed unevenly. The annual average losses are approximately 19-20%. However, during the summer heat losses may reach 50% of the heat invoiced due to the very low DHW demand.

Water losses through leakages are recorded as 566,000 m<sup>3</sup>/a for 2016, and 535,000 m<sup>3</sup>/a for 2018, which is equivalent to approximately 10 m<sup>3</sup> of make-up water per one m<sup>3</sup> of volume of the DH network (approx. 53,000 m<sup>3</sup>). With the implementation of the DH network rehabilitation measures the water losses are expected to be reduced.



WORLEYPARSONS FOR USAID

# ASSESSMENT OF LOCAL POWER GENERATION OPTIONS IN MOLDOVA,

## Progress Report, July 2019

ATTACHMENT D – LEGAL AND REGULATORY CONSIDERATIONS.  
FINDINGS SUMMARY

*DISCLAIMER This report is made possible by the support of the American People through the United States Agency for International Development (USAID). The contents of this report are the sole responsibility of WorleyParsons and do not necessarily reflect the views of USAID or the United States Government.*

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## INTRODUCTION

The objectives of this task are as follows:

- Identify legal/ regulatory issues concerning construction and operation of heat & power generation and supply in Moldova and EU
- Summarize legal and regulatory issues to be addressed in next phase of feasibility assessment, planning, procurement, and construction. The summary shall include social and environmental issues, as well as licensing, and certification process required by current Moldovan law and EU directives
- Highlight steps for compliance with all requirements
- Note/ appraise potential roadblocks/ difficulties in relation to heat and power generation options in Moldova

## FINDINGS SUMMARY

Moldova is highly dependent on electricity imported from Ukraine or produced in the Transnistria region (over 80% of the country's total energy demand). In order to ensure the RoMs security of supply, the new Greenfield project should be awarded strategic importance. The government should support its implementation through legislative development, enable a fast-paced implementation and ensure the security of the energy source.

The European energy legal system, in particular the Third Energy Package, should be fully implemented in the Republic of Moldova. Currently, the energy legal system in place in Moldova is not fully compliant with the system applicable in the ENTSO-E countries, although there is an evolution in the right direction.

Moldova has been taking necessary steps towards transposing the Energy Community acquis, though implementation is still at an early stage and behind schedule, having reached no more than 38% overall implementation, according to the Energy Community Secretariat 2018 Annual Report. On the plus side, RoM has declared its commitment to implement the needed reforms of the electricity market.

Specifically, the legal framework is missing several primary and secondary legislative acts, relevant to the construction of new electricity generation assets. Among others, Moldova still needs to address:

- Regulation on tendering for new generation capacities
- Technical norms that regulate the establishment and operation of power plants

In terms of potential risks, any future investor would need to consider the following:

- Missing or unclear primary and secondary legislation
- Electricity market structure, environmental, licensing and certification process elements need to be improved and adapted to avoid delays in the build-up / construction phase

- Security of supply risk given the significant dependency on imported natural gas, as the natural gas supply contract with external supplier (Gazprom) expires in 2019
- Vestmoldtransgaz, in charge of building the new gas pipeline between Ungheni and Chisinau, may not be able to start and/or complete the project in time
- Potentially limited energy export options due to early stage of interconnection with ENTSO-E high voltage electricity networks
- Authorities' intention to implement a capacity market mechanism to offer a state aid scheme to a brownfield/greenfield power generation facility
- Finally, as the largest current power generation unit is located in Transnistria, there is a risk of non-adherence or non-compliance from CERS side to the future applicable primary and secondary energy legislation

## **CHANGES AND IMPROVEMENTS NEEDED TO ACCOMMODATE NEW POWER GENERATION ASSET**

Below we have compiled a list of the most relevant secondary legislation with which a new power plant project would need to comply, and which is not directly addressed by existing regulation:

1. Guideline on the Application of the Environmental Impact Assessment Procedure
2. Regulation on tendering for new generation capacities
3. The requirements for the minimum reserves of fossil fuels for power plants operation
4. Appointment of the electricity market operator
5. Regulation for the protection of electricity networks
6. Regulation on emergencies in the electricity market and the contingency plan in emergency situations in the energy market
7. Technical norms that regulate the establishment and operation of power plants, electricity networks and electrical installations of final customers
8. Methodology for calculation, approval and application of tariffs for connection to the networks
9. General terms and conditions of electricity supply agreements of the universal service supplier and last resort supplier to end customers
10. Methodology for the calculation, approval and application of regulated tariffs for the service of electricity market operation

- I 1. Methodology for calculation of fees for the imbalances
- I 2. Regulation on reporting to the ANRE by the licensees
- I 3. Electricity Network Codes
- I 4. Ten Year Network Development Plan (TYNDP)

## **TENDERS FOR THE CONSTRUCTION OF NEW CAPACITIES OR FOR INCREASING EXISTING POWER GENERATION CAPACITIES**

For a better understanding of the regulatory context, we translated (and adapted for further clarity- see italic format) the most relevant aspects of the governmental draft on Regulations that applies to Tenders for the new capacities construction or for increasing the existing power generation capacities:

*(...) The Government is in charge with the following tasks:*

- *Establishes the type of auction;*
- *Establishes the subject of the auction, including the type of new capacity development projects (construction of a new power plant, capacity increase of an existing power plant, construction of new electrical capacities due to the reconstruction and refurbishment of an existing thermal power station in the district heating plant/ district heating plants);*
- *Establishes the size of the project, the location of the power plant and the type of production technology to be used.*

*(...) The Central specialized body shall fulfill the following tasks:*

- *Analyzes, (...) the situation created on the domestic electricity market and proposes to the Government the draft decision on the organization of the tender for the development of new production capacities;*
- *Develops the tender documentation, including the participation notice;*

*(...) The Auction Commission carries out the following tasks:*

- *Initiates and organizes the tender procedure;*
- *Prepares and presents to the Government the materials on the results of the tenders.*

*When assessing the need to organize the auction, the Central specialized body will:*

*I) Analyze*

- a. the medium and long-term forecast of energy demand and supply;*

- b. the existing domestic electricity market and the prospects for its development;
- 2) Determine the level of new production capacities needed to be built to ensure the security of electricity supply, taking into account the existing and planned capacities to be developed (including capacities authorized by the Government in accordance with Article 20 of Law No. 107/2016 on electricity and capacities to be developed in the context of the implementation of the support scheme established by the Law No 10/2016 on the promotion of the use of electricity from renewable sources);
- 3) Examine
  - a. The existing situation and availability of primary energy resources in the country and from the import that can be used by new generation capacities;
  - b. The types of technology used;
  - c. The location of new power plants;
  - d. The environmental impact of new production capacities to be developed;
- 4) Examine and identify the optimal options for the development of new production capacities (construction of new power plants, increase of existing power plants capacity, reconstruction / refurbishment of existing thermal power plants in district heating plants);
- 5) Estimate the costs necessary to build new production capacities and identifies the possible sources of financing (state budget sources, funds obtained from international lending institutions, funds obtained from external partners and donors, private investments or public-private partnerships, etc.) establishing the methodology to award the contracts as well as the social impact of the new capacity development projects implementation;

The Specification must include, without limitation, the following information:

(...) the type of production technology, the conditions imposed on the technological profile of the equipment, the capacity factor and the service duration;

(...) the specifications and technical characteristics of the production equipment (generators, turbines, boilers, motors, transformers, distribution devices, switches, separators, compensators, automation and protection systems, etc.) linked to the requirements for compliance and quality, performance and efficiency, environmental, operability and maintenance, safety in operation, warranty and post-warranty terms;

(...) location requirements and detailed information for the installation phase access and for the power plant operating access and, where appropriate, specific data on the location of the power plant (topography, geology, mechanics soil and seismology, hydrology, meteorology, traffic routes, etc.);

(...) requirements on fuel supply and fuel storage capacity needed in order to produce electricity;

Depending on the financing source, the level of economic operators' involvement and the ownership foreseen for the new production plants to be developed, the following types of contracts might be awarded within the framework of tenders organized in accordance with this Regulation:

- a) Contract for the development of capacities, production and acquisition of electric power;
- b) Contract for the construction of electricity generation capacities;
- c) Contract based on public - private partnership.

The contract for the development of the new electricity plant, production and purchasing is a contract concluded between the entity designated by the Government and the tender winner for the final auction. The object will be the development of new production capacities (from the conceptual design of the project, financing, designing and procurement of equipment, construction) and production capacities operation / exploitation. This type of contract may be used in tenders organized in connection with the construction and operation by operators of new power plants if the successful tenderer intends to become an electricity producer operator following the construction.

The contract for the construction of electricity generation capacities is a contract concluded between the entity designated by the Government and the successful tenderer of the auction and implies the construction of the new production capacities. This type of contract is awarded if economic operators only provide design of new production capacities, procurement (including delivery) of necessary equipment, execution of construction and assembly works and put in function the new production capacities. In this case, the respective economic agent neither finance the project, nor owns or operates the new production facilities.

The Public-Private Partnership Contract is a contract concluded with the successful tenderer aiming to create a public-private partnership for the allocation of infrastructure assets, resources, bonds, risks and responsibilities associated with the development projects of the new power generation capacities, observing the requirements established by the Law no. 179/2008 on public-private partnership.

(...) The technical capacity test demonstrates the existence of a minimum technical endowment of the machinery, equipment, special technique, etc., in accordance with the requirements set out in the Tender Specifications, deemed necessary for the performance of the contract awarded following the tender.

The existence of technical endowment is demonstrated by the economic operator through the fixed assets documentation presented, copies of its rental / commodity contracts.

The technical proposal shall be structured by the bidder so that it provides all the necessary information and demonstrates its compliance with the technical requirements set out in the Tender Specifications. The technical proposal must contain at minimum the following information and documents:

1. The description and general characteristics of the proposed project (structure, size, technology used, installed power, capacity factor, efficiency, duration, etc.);
2. The specifications and technical characteristics of the key power generation equipment (name, type of equipment, manufacturer, year of manufacture, compliance with technical requirements, compliance and quality, efficiency and environmental requirements, with industry standards, as well as the normative and technical documents, indicated in the Tender Specifications), as well as the procurement plan for this equipment. This plan must demonstrate the existence of a commitment or option agreed with the manufacturers or suppliers with regard to the acquisition and / or delivery of the key equipment within a

timeframe that allows the construction to be completed within the terms set out in the Tender Book tasks (including procurement contracts, guarantees, letters of interest, etc.);

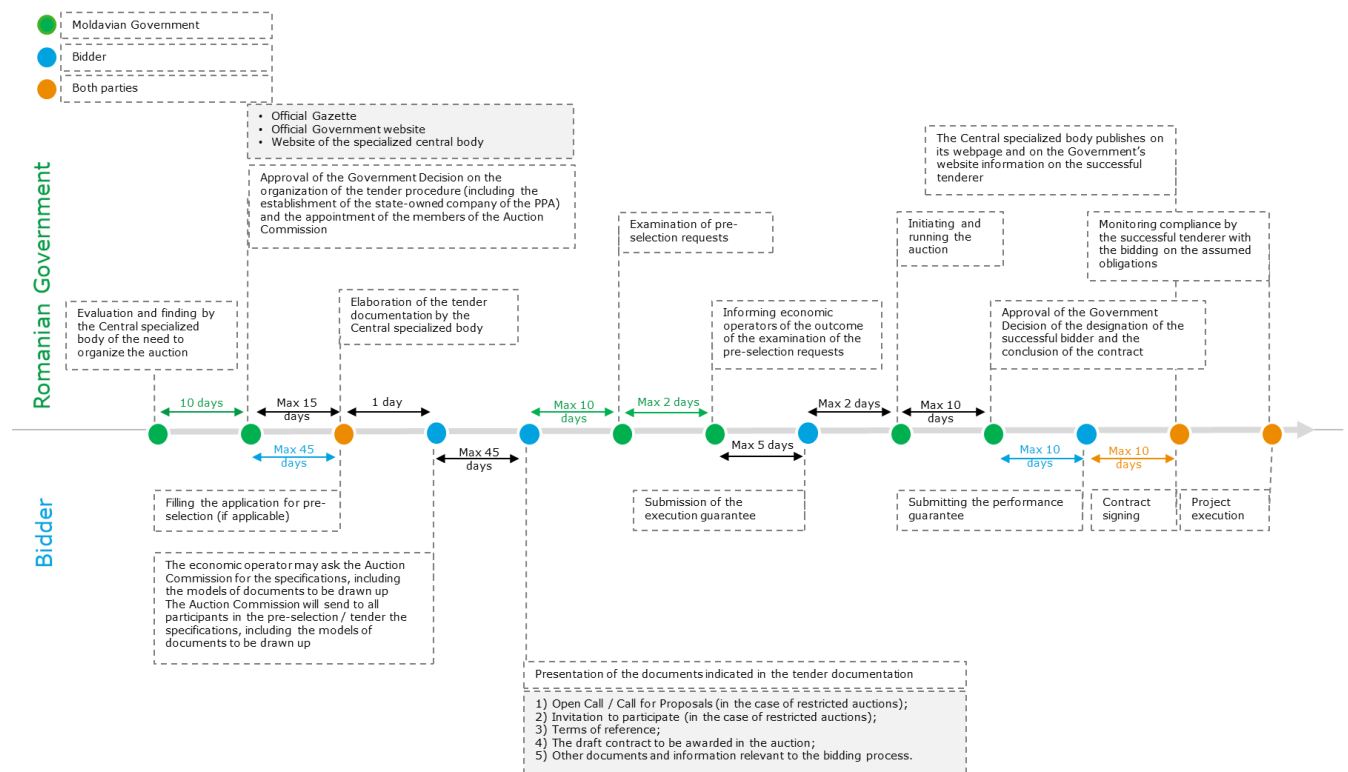
3. The impact of new production capacities on the environment, which must not exceed the emission levels set out in the Tender Specifications. The environmental impact is demonstrated by presenting the respective emission data / calculations resulting from the operation of the respective production capacities separately for each type of emission as well as in full, set in common units such as gram per kilowatt hour (g / kWh);
4. The location of new production capacities, the eligibility of land for the location of the new power plant or for increasing the existing power plant capacity and access to the existing infrastructure. The bidder demonstrates eligibility of the land by presenting the following information and documents, as appropriate:
  - a) Presentation and description of the location plan in the respective area;
  - b) Information describing access to water, sewerage, railways and access roads (both public and private roads);
  - c) Presentation of the list of land/ parcels required for the location, the documents proving the proof of ownership or use on the land/ parcels, including the extracts from the Register of immovable property and, as the case may be, the proof of the change of the destination of the agricultural land and/ or the file on the change of the land use category, drawn up in accordance with the Regulation on the mode of transmission, destination change and land exchange, approved by the Government Decision no. 1170/2016;
5. The basic and reserve fuel supply plan used to produce electricity to ensure the viability and reliability of fuel supply. The viability and reliability of fuel supply is demonstrated by the submission of contracts, warranties, letters of interest from producers or suppliers of fuel to ensure the long-term purchase of fuel, the existence or development of sufficient capacity for fuel storage in order to ensure operational activity, as well as reserve fuel, etc.
6. The electrical network connection plan demonstrating the viability of the new power plant or of the existing power plant with increased capacity. The network connection notice should be attached, issued by the system operator. In case of lack of capacity in the network, should be attached the extract from the latest electricity grid development plan and confirmation by the system operator that the respective grid is to be developed or its existing capacity is to be increased within the time frame foreseen for the construction of the new production capacities.

## **PROPOSAL FOR IMPROVING THE TENDERING REGULATION**

Our analysis revealed the following points should be addressed/ revised by the Moldovan Government (“the Government”) regarding the principles, clarity and phrasing of the “REGULATIONS on conducting tenders for the construction of new capacities or for increasing existing power generation capacities” (“the Regulations”):

1. In the case of a Build-Own-Operate contract, which will be the entity the Government will designate to buy the electricity produced by the power plant?
2. In the case of a PPA, what will happen with the ownership of the plant after the end of the agreement?
3. What are the means by which the investor is protected from the changes in the political will?
4. What steps will the Government take to ensure a transparent, objective and just tender procedure?
5. What international arbitration institutions and courts of law is Moldova part of?
6. For the process to take place faster, we propose setting maximum durations for each step. An example of such an improvement is shown with red in the following timeline:

Exhibit 1 Proposed maximum duration of steps for the process of increasing existing power capacities



Source: Deloitte analysis

## STEPS FOR COMPLIANCE WITH ALL REQUIREMENTS

### COMPLIANCE OBLIGATION

Energy Community Accession<sup>1</sup> – Compliance Obligations:

1. Directive 2003/54/EC concerning common rules for the internal market in electricity – by 31 December 2009
2. Directive 2003/55/EC concerning common rules for the internal market in natural gas – by 31 December 2009
3. Regulation no. 1775/2005 on conditions for access to the natural gas transmission networks – by 31 December 2010
4. Directive 2004/67/EC concerning measures to safeguard security of natural gas supply – by 31 December 2010
5. Regulation 1228/2003 on conditions for access to the network for cross border exchanges in electricity – by 31 December 2010
6. Commission Decision 2006/770/EC amending the Annex to Regulation no 1228/2003 on conditions for access to the network for cross-border exchanges in electricity – by 31 December 2010
7. Directive 2005/89/EC concerning measures to safeguard security of electricity supply and infrastructure investment - By 31 December 2010
8. Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment, as amended by Directive 97/11/ EC and Directive 2003/35/EC – by 31 December 2010
9. Plan for the implementation of Directive 2001/77/EEC on the promotion of electricity produced from renewable energy sources in the internal electricity market – by 31 December 2010
10. Plan for the implementation of Directive 2003/30/EC on the promotion of the use of biofuels or other renewable fuels for transport – by 31 December 2010
11. Directive 79/409/EC, Article 4(2), on the conservation of wild birds – by 31 December 2010

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<sup>1</sup> DECISION OF THE MINISTERIAL COUNCIL OF THE ENERGY COMMUNITY D/2009/03/MC-EnC on the accession of the Republic of Moldova to the Energy Community Treaty

12. Directive 1999/32/EC relating to a reduction in the Sulphur content of certain liquid fuels – by 31 December 2014
13. Directive 2001/80/EC on the limitation of emissions of certain pollutants into the air from large combustion plants – by 31 December 2017

## STATUS OF COMPLIANCE

The Republic of Moldova authorities have signaled their commitment to continue the energy sector reform and the electricity market establishment. A sector reform program was agreed with international partners' operational and financial support (EBRD, EIB, EU, EnCS, and WB)<sup>2</sup>. The program titled Power Sector Action Plan (PowerSAP), that aims to create a competitive electricity market in Moldova while ensuring cost recovery, will promote and support reform agenda, draft the Wholesale Electricity Market rules and review transmission tariffs.

The ongoing “Energy Sector Management Advisory Program” funded by World Bank<sup>3</sup> should most likely conclude in 2019 and should identify the optimal electricity market design to achieve competitive and transparent electricity sector environment.

According to the 2018 Implementation Report issued by the Energy Community Secretariat, assessing the contracting parties' implementation of the Treaty<sup>4</sup> acquis, the Republic of Moldova has made some progress but still need to catch up, having an overall implementation score of 38%, with electricity sector still at an early stage (32% implementation score)<sup>5</sup>.

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<sup>2</sup> The World Bank Report No. PAD3147, April 9<sup>th</sup>, 2019, Project Appraisal Document On A Proposed Credit

<sup>3</sup> Promoting Competition in Moldovan Electric Power Market through Regional Integration (P166195) funded by World Bank

<sup>4</sup> Energy Community Treaty/29.05.2006

<sup>5</sup> <https://www.energy-community.org/implementation/IR2018/methodology.html>

Exhibit 2 Summary overall implementation of the Third Energy Package in Moldova (38%)

Summary Indicators	Implementation Status		Descriptions
 Electricity		32%	Implementation in the electricity sector of Moldova is still at an early stage
 Gas		22%	Implementation in the gas sector of Moldova is still at an early stage
 Renewable Energy		65%	Implementation in the renewable energy sector of Moldova is well advanced
 Energy Efficiency		69%	Implementation in the energy efficiency sector of Moldova is well advanced
 Environment		60%	Implementation in the environment sector of Moldova is moderately advanced
 Climate		17%	Implementation in the climate sector of Moldova is yet to begin
 Infrastructure		18%	Implementation in the infrastructure sector of Moldova is yet to begin
 Statistics		94%	Implementation in the statistics sector of Moldova is almost completed






Source: Energy Community Secretariat 2018 Annual Implementation Report

With respect to the implementation of the Third Energy Package, Moldova has taken steps in the right direction, through the adoption of the Electricity law, steps which include the beginning of the electricity TSO's unbundling process and the endorsing of the wholesale market concept. The Electricity Law transposes the unbundling requirements of Directive 2009/72/EC.

According to the Electricity law, the decision to unbundle generation and supply activities of Moldelectrica was adopted by the Government in August 2018.

Although the three DSOs are also legally separated from supply, their actual functional unbundling is still to be finalized.

Exhibit 3 Overall implementation score on electricity (32%)

Electricity Indicators	Implementation Status	Descriptions
Unbundling	 25%	<ul style="list-style-type: none"> <li>The Government adopted an unbundling decision for Moldelectrica in August 2018 enabling the company to apply to the regulator for certification under the Third Energy Package rules</li> <li>Functional unbundling of the DSOs has to be finalized for all private and state-owned companies</li> </ul>
Access to networks	 44%	<ul style="list-style-type: none"> <li>The tariffs are approved and published.</li> <li>Allocation of cross-border capacities with the Ukrainian system are not performed based on market principles and fail to comply with Regulation (EC) 714/2009</li> </ul>
Wholesale market	 21%	<ul style="list-style-type: none"> <li>Wholesale electricity prices are market-based except for the domestic combined heat and power plants</li> <li>The day-ahead and balancing markets, as well as their transparency, are still to be implemented</li> </ul>
Retail market	 61%	<ul style="list-style-type: none"> <li>All customers are eligible, nevertheless, regulated supply services are still accessible to all customers</li> </ul>
Regional integration	 9%	<ul style="list-style-type: none"> <li>There is no bilateral market integration with Ukraine yet due to delays in market reforms in both countries</li> <li>The interconnection project with Romania has advanced with the endorsement of the loan agreements by the Government</li> <li>Connection Network Codes are yet to be transposed</li> </ul>

Source: Energy Community Secretariat 2018 Annual Implementation Report

A vast majority of the Third Energy Package was transposed through the adoption of the Law on Natural Gas in 2016. Since then, the main secondary legislation was drafted with support from the Energy Community Secretariat, with only few legal acts actually being adopted to date.

## POTENTIAL ROADBLOCKS / DIFFICULTIES

### SUPPLY CHAIN ISSUES

1. The Gas Supply contract with the external supplier expires in 2019 and the negotiations for extension did not start / will be most likely difficult.
2. Given the current single major gas supplier situation, there is an inherent security of supply risk to be addressed and other gas supply sources should be made available (i.e. Romania, Ukraine, etc.). In 2018, Vestmoldtransgaz (the other transport operator in Moldova) was acquired by the Romanian natural gas transport operator, which created

the necessary framework to develop the Ungheni – Chisinau pipeline, a vital project to ensure Moldova’s security of supply.

3. The High Voltage Interconnections with EU is still in planning phase, so the energy export options are limited – a risk any future operator should be concerned with
4. Capacity market not in place yet – the commercial model applicability is limited and the risk of dumping prices will have to be considered.

## LEGAL ROADBLOCKS

The build-up / construction phase might encounter delays. A special legal frame for Projects of National Interest would help controlling the calendar and the costs:

1. Temporary or permanent usage rights for publicly owned lands needed for power plants access or operations should be granted without renting or other compensatory costs (i.e. lost revenue) during the entire period of utilization.
2. Temporary or permanent usage rights for privately owned lands needed for power plants access or operations should be compensated for renting and other lost revenues, based on mutual agreement with the owner.
3. If the agreement above cannot be reached in due time for any reason (i.e. unknown owner, unclear legal status, etc.) the construction and the operations shall still go on, the estimated expected compensation shall be deposited in an escrow account and the issue can be subsequently settled in court.
4. Once the Government declare the project “of National Interest”, the construction and land permits and authorizations issued by local authority would no longer need to precede the construction and operations activities.
5. The usage and access rights cannot be suspended during the operational phase.
6. If special conditions apply, the usage and access rights may be established by the Government within national parks’ protected & buffer zones.
7. Once the operational phase ends, the land asset must be returned to the rightful owner free from any structural or environmental changes, restored to its initial status and usage.

## STRATEGIC AND OTHER CONSIDERATIONS

1. The regional political and strategic interests would maintain legal uncertainty for unsolved territorial issues and claims and may manipulate the market mechanisms in order to determine geopolitical gains.

2. The existing limited capacity of electricity generation on the right bank of Nistru River while the majority of the supply comes from the left bank of Nistru River or from Ukraine (via power lines also crossing the left bank territory) represent a serious threat of the energy supply security for RoM.
3. The Electricity Transmission Network is synchronized with the Integrated Power System (of Ukraine, Kazakhstan and other Community of Independent States) and mutually dependent of the Unified Power System of Russia. The ENTSO-E (including Romanian) system grid is neither linked nor synchronized.
4. The secondary gas operator (Vestmoldtransgaz) in charge of building the new gas pipeline between Ungheni and Chisinau may not be able to start and/or complete the project aimed to diversify the supply routes to RoM. The project is expected to build by December 2019 a new 120 km pipeline able to transport up to 1.5 bn. cubic meters of gas from Romania to Chisinau.
5. Issuing new water permits for new projects water supply might also be a roadblock given the Ukraine planned hydropower capacity to be built on the Nistru River upstream of the RoM borders. Ukraine or RoM have not evaluated the downstream implications yet.
6. Location (e.g. to accommodate connections to the power grid, access to water and natural gas) and land availability would be key drivers in the economics of the greenfield power generation project. Our research indicated that a previous location considered for a large gas-fired combined cycle power plant was Burlaceni<sup>6</sup>
7. As an alternative to a capacity market mechanism support type, investors might consider the Government-led programs for Public-Private Partnership (PPP). While recognizing the shortage of public funds, in order to address the under-developed services and infrastructure upgrades, the current RoM authorities display an encouraging openness to join ideas, projects and programs aim to provide effective, but still efficient, services for the population, including power generation/ supply.

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<sup>6</sup> Government Decision no. 713/2004, on the construction of a power plant in the vicinity of the village of Burlaceni, Cahul district